GeothermEx, Inc. 901 MENDOCINO AVE.
BERKELEY, CA. 94707

(415) 527-9876

GEOLOGY AND THERMAL REGIME

OF

BERT WINN #1 GEOTHERMAL TEST,

FRANKLIN COUNTY,

IDAHO

for

SUNOCO ENERGY DEVELOPMENT CO.

DALLAS, TEXAS

by

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Berkeley, California

December 1980

DISCLAIMER

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CONCLUSIONS

1. Bert Winn #1 did not encounter high-temperature zones of permeability, except possibly at 5,575 to 5,700 feet, where chloride conductivity indicates saline fluid entry, and where stabilized temperature may be 210°-215°F.

2. Structurally, Bert Winn #1 appears to have penetrated into the horst footwall block, penetrating progressively away from the horst-bounding faults believed to leak hot fluids.

3. Projections based on disequilibrium temperatures taken at 24 and 36 hours suggest a stabilized maximum temperature of about 260°-265°F at 7,450. Maximum observed temperature was 243°F.

4. Geochemically, temperatures at depth should be over 300°F. On the basis of observed temperatures and gradients, 400°F might not be encountered until 12,000 feet at this site.

5. C. H. Stocks 1-A, about one mile northwest, appears to be hotter at comparable depths, and to be better located to penetrate the range-front fault set at drillable depth.

6. Bert Winn #1 was sited principally on a geoelectrical anomaly in an area of high temperature gradients. With the remote exception of the saline interval at 5,575 to 5,700 feet, no evidence was seen in drilling and logging of any feature that could serve as the source of the geoelectrical anomaly.

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RECOMMENDATIONS

1. Acreage on the Little Mountain horst may be released; acreage down-dip on the eastern and western horst-bouding faults may be kept, farmed out or pooled with those of any operator willing to test this flank-fault prospect.

2. Locations for such a deep test should be sufficiently down-dip along the horst-bounding fault to yield intersection at 8,000-10,000 foot depth. Alternatively C. H. Stock 1-A may be deepened to that depth.

3. No further geoelectrical or shallow gradient surveys are warranted. Detailed gravimetry may be useful in locating the frontal faults with greater precision.

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LOCATION

The Sunedco Bert Winn #1 geothermal test is located at a site 888 feet north and 396 feet east of the SW corner of Sec. 8, T. 15 S., R. ~~35~~ 39 E., Franklin County, Idaho. The ground elevation of the hole, estimated from the topographic map, is approximately 4,615 feet. The site is an ancient river terrace cut in Quaternary fluvial and lacustrine sediments covering the floor of Cache Valley. It is approximately one mile southeast of the nearest exposures of Precambrian rocks on Little Mountain, and approximately one mile southeast of the unsuccessful Sunedco C. H. Stocks No. 1-A geothermal test, drilled to a depth of 5,479 feet in July and August 1978 (plate 1). The site can be reached from the town of Preston by traveling west on the Dayton road about 2.5 miles to Hot Springs Road and the north about 2.2 miles to the drillsite.

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SUMMARY OF DRILLING OPERATIONS

The drilling contractor for this hole was Brinkerhoff-Signal, using rig 15. Drilling began on April 4, 1980. Thirty-inch pipe was set at 53 feet. Twenty-six-inch hole was drilled to 344 feet and 20-inch casing set at 330 feet. Seventeen and one-half-inch hole then was drilled to 1,739 feet and 13-3/8-inch casing was set at 1,733 feet. Thereupon, a 12-1/4-inch hole was drilled from 1,733 feet to 5,575 feet, where partial lost circulation was encountered. This was followed by a total loss at 5,580 to 5,585 feet. Lost circulation material was added to the mud and the hole was drilled ahead without returns to 5,666 feet. At this depth, two Kuster wireline temperature surveys were run, and a cement plug was set to shut off the lost circulation zone. Drilling was resumed in 12-1/4-inch hole with partial losses of drilling fluid varying from 20 to 35 barrels per hour, principally or totally in a zone at about 5,585 feet.

An additional fluid loss of about 100 barrels occurred at 7,203 feet. This was cured by addition of lost circulation material to the mud. Drilling continued to 7,444 feet, where 3 Kuster wireline temperature surveys were run. Drilling then resumed to a depth of 7,981 feet, at which depth Schlumberger surveys were run as indicated below. The well then was filled with light mud and suspended. The rig was released on June 15, 1980, the 72nd day of drilling operations.

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LOGGING

The following logs were run:

1. Geophysical Logs

CONTRACTOR	LOG TYPE	RUN NO.	DATE	INTERVAL (feet)
Schlumberger	Dual Induction	1	6/14/80	1,733-7,967
	Compensated Neutron-Formation Density-Gamma Ray-Caliper	1	6/14/80	1,733-7,967

2. Temperature Surveys

CONTRACTOR	LOG TYPE	RUN. NO.	DATE/TIME	TIME SINCE CIRCULATION	INTERVAL (feet)
Cable Well Servicing Company*	Kuster	1	5/11/80; 1300-1540	11-13 1/2 hr.	500-5,650
"	"	2	5/11/80; 1600-1900	14-17 hr.	500-5,650
Pruett*	Kuster	1	6/7/80; 0816-1111	9 hr. 41 min. 12 hr. 36 min.	1,000-7,450
"	"	2	6/7/80; 2100-2350	22 hr. 25 min. 24 hr. 22 min.	1,000-7,450
"	"	3	6/8/80; 0853-1127	34 hr. 18 min. 36 hr. 52 min.	1,000-7,450
Schlumberger	High resolution thermometer	1	6/13-14/80; 2230-0130	6 hr. 28 min. 9 hr. 28 min.	200-7,922
"	"	2	6/14/80 1400-1700	21 hr. 28 min. 24 hr. 28 min.	200-7,970

*Wireline temperature survey data are compiled in table 1.

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Table 1. Summary of temperature surveys, Bert Winn #1.

Surveys of 5/11/80: Kuster Wireline; Cable Company, contractor
Surveys of 6/7 and 6/8/80: Kuster Wireline; Pruett Company, contractor

	Temperature, °F	
	5/11/80, RUN 1	5/11/80, RUN 2
Depth, feet	(11 hrs. after circ.)	(14 hrs. 30 min. after circ.)
500	61.9	62.5
1,000	81.4	82.2
1,500	143.7	148.1
2,000	146.5	148.9
2,500	177.4	176.7
3,000	170.0	170.0
3,500	166.3	167.7
3,600	165.1	167.8
3,700	164.7	167.9
3,800	164.9	168.1
3,900	165.2	168.6
4,000	165.8	169.2
4,100	166.5	170.1
4,200	167.4	171.1
4,300	168.5	172.4
4,400	169.8	173.6
4,500	171.1	174.7
4,600	172.6	176.0
4,700	174.5	178.0
4,800	176.2	180.1
4,900	176.4	181.2
5,000	176.3	182.9
5,050	176.0	184.2
5,100	176.5	184.9
5,150	176.5	185.0
5,200	176.7	185.3
5,250	177.0	185.1
5,300	177.0	185.6
5,350	176.3	185.7
5,400	176.5	186.5
5,450	176.7	187.0
5,500	177.6	187.3
5,550	179.1	192.1
5,600	183.3	206.5
5,650	197.0 (after 28 min. on bottom)	209.1 (after 20 min. on bottom)

Time at each station was 3 minutes, except on bottom as noted.

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Table 1 (continued)

	6/7/80, RUN 1 (9 hr. 41 min. after circulation broken)		6/7/80, RUN 2 (22 hr. 25 min. after circulation broken)		6/8/80, RUN 3 (34 hr. 18 min. after circulation broken)	
Depth, feet	T, °F	Time	T, °F	Time	T, °F	Time
1,000	158.9	0828	169.03	2110	173.80	0853
2,000	173.95		176.83		176.61	
3,000	166.0		172.06		174.66	
4,000	170.6		179.43		183.33	
4,500	174.78		185.50		189.40	
5,000	179.59		190.48		195.68	
5,250	182.1		193.08		199.36	
5,400	183.15		193.95		200.88	
5,500	184.62		194.81		202.18	
5,585	185.03		195.03		202.40	
5,700	185.24		195.68		203.91	
5,800	185.87		197.85		205.0	
5,900	188.38		201.10		206.73	
6,500	195.91		210.41		217.92	
7,000	197.79		215.37		223.23	
7,205	200.31		218.98		226.20	
7,300	204.07		222.16		230.87	
7,400	211.76		229.60		236.81	
7,450	211.95	1021	230.23	2257	238.51	1054
7,450	212.95	1036	233.84	2312	242.55	1109
7,450	214.33	1051	234.69	2327	242.97	1124
7,450	215.72	1106	235.54	2342	242.97	1127[3]
7,450	216.32	1111[1]	235.75	2350[2]	-	-

[1] 12 hr. 36 min. after circulation broken.
[2] 24 hr. 22 min. after circulation broken.
[3] 36 hr. 52 min. after circulation broken.

3. Mud Logging

A Bariod mud logging unit was in operation from a depth of 530 feet to total depth of 7,981 feet. A copy of the mud log is included as Appendix B.

GEOLOGIC SETTING

An outline of the geologic history of the area appeared in the report covering the drilling of the Sunedco C. H. Stocks 1-A well (McIntyre and Koenig, 1978). This summary is repeated here, including revisions that have been made in Precambrian stratigraphy since that report was written.

The Preston prospect is located in the northern end of Cache Valley, a major graben of Late Cenozoic age near the northeastern edge of the Basin and Range Province. The graben floor is covered by dissected Pleistocene lacustrine sediments, which overlay a thick Late Tertiary tuffaceous sequence of fluvial and lacustrine origin. Pre-Cenozoic rocks, ranging from Precambrian to Middle Palezoic age, are well-exposed in the flanking Bear River Range to the east, the Bannock Range to the west, and in small intra-valley horsts, such as Little Mountain on which the prospect is located.

Three assemblages of Precambrian rocks are present in the region. The oldest of these consists of the Farmington "complex" of the northern Wasatch Mountains and Antelope Island, 50 to 150 miles south of the Preston area, and the Green Creek "complex" of the Raft River-Albion Ranges, 90 to 100 miles west of Cache Valley. The Farmington complex is about 90% granitic gneiss, with about 5% amphibolite and pegmatite. Near Ogden, Utah, the gneiss and migmatite contain quartz, microcline, sodic plagioclase, biotite and variable hornblende and almandite. The few available radiometric dates range from 1.6 to 1.8 billion years (Condie, 1969). On Antelope Island, Utah, rocks assigned to the Farmington complex consist of more than 20,000 feet of quartzo-feldspathic schist, microcline schist, quartz schist and metaquartzite. No detailed descriptions of the sequences are available.

The Green Creek complex of the Albion Range consists of three main rock types: (1) porphyritic adamellite to quartz dioritic gneiss; (2) dark-colored biotite-quartz-oligoclase schist; and (3) hornblende-andesine-quartz amphibolite. They have been dated as 2.5 to 2.7 billion years old (Armstrong, 1968). Although the metamorphic history in each area is different, the oldest Precambrian rocks are characterized everywhere by their relatively high metamorphic grade.

The middle assemblage of Precambrian rocks consists of several thousand feet of sedimentary and local basic volcanic rocks, characteristically metamorphosed to the greenschist stage. These rocks are exposed extensively in the Bannock and Portneuf Ranges and in Little Mountain. They are assigned to the Pocatello Formation. Equivalent rocks also are present in the northern Wasatch Mountains and southern

Promontory Range in adjacent parts of Utah. The base of the Pocatello Formation is not exposed in southeastern Idaho, but it has been observed to rest unconformably on the Farmington "complex" at Fremont Island, Utah, and elsewhere. The Pocatello Formation stratigraphy has undergone revision since its redefinition by Trumble (1976). A summary of the units is given in table 2, derived from Crittenden (1971), Link et al. (1980) and Trumble (1976). Unfortunately, no detailed stratigraphic sections have been published to assist in defining the complex relationships between the various rock types in the Pocatello Formation, particularly lateral facies changes.

Late Precambrian rocks are also present in the Raft River-Albion Range area, unconformably overlying the Green Creek complex. The section there is complicated by local metamorphic facies and by intense deformation. The base of the section in the Albion Range consists of about 800 feet of the Elba Quartzite, a vitreous white quartzite with thin interbeds of quartz-muscovite schist. In the Raft River Range, some of this quartzite is colored bright green by chromium-bearing muscovite (fuchsite). The Elba Quartzite is overlain by quartz-mica schist, quartzite, quartz-amphibole schist, graphitic garnet-staurolite schist and marble. The stratigraphic relationship of this assemblage to the Pocatello Formation and overlying younger quartzite of southeastern Idaho is not known. The unusually high metamorphic grade found in the Albion-Raft River area rocks, compared to the greenschist stage found in the Pocatello Formation, reportedly is due to their association with the development of a mantled gneiss dome in Late Mesozoic time (Armstrong and Hansen, 1966).

The third and youngest sequence of Precambrian rocks in the project area consists of thick quartzite containing minor amounts of argillite and a single limestone unit. Quartzites of this age and type are widely distributed in the eastern Basin and Range Province. The character of the local section is summarized in table 2. Its distinguishing features are (1) low metamorphic grade, and (2) the predominance of pure quartzite units, compared to the abundance of argillaceous, silty and volcanic material found in the Pocatello Formation.

The depositional configuration of Late Precambrian rocks resembles that of the overlying Paleozoic rocks, with great thicknesses present in a belt extending from southern Nevada and southeastern California northeastward through western Utah, eastern Nevada and southeastern Idaho. To the east of this zone, in Wyoming and eastern Utah, except for the Unita Mountains, these rocks are thin or absent.

During Paleozoic and Early Mesozoic time, as much as 50,000 feet of limestone, dolomite, minor quartzite and shale was deposited

Table 2. Stratigraphy of Precambrian and lowermost Cambrian units, Bannock and Portneuf Ranges, southeastern Idaho. (from Trimble, 1976; Condie, 1969; Link, et al., 1980)

Generalized Lithology	Thickness Feet	
	1,000 ±	GIBSON JACK FORMATION (Lower Cambrian) Siltstone, argillaceous with argillite and minor sandstone or quartzite, brown, tan, olive to grey-green
	3,500 ±	CAMELBACK MOUNTAIN QUARTZITE (Lower Cambrian and Precambrian?) Quartzite, white, weathers tan to brown; thick-bedded to massive
	3,000 ±	MUTUAL FORMATION (Precambrian) Quartzite, light to dark grey-red and purple-black; coarse-grained to conglomeratic; interbedded with argillite members up to 200 feet thick, dark red and locally olive
	800 - 2,300	INKOM FORMATION Argillite, grey-red to rust; phyllite or argillite, green; with minor fine-grained quartzite and micaceous quartzite
	6,500 ±	CADDY CANYON QUARTZITE Argillite and siltite, greenish; interbedded with quartzite Quartzite interbedded with argillite, pink, purple and maroon Dolomite or limestone (50' ±) Quartzite, weathers white to tan, vitreous, locally thick-bedded; with minor interbedded green argillite
	1,800 ±	PAPOOSE CREEK FORMATION Siltite and very fine-grained quartzite, grey and brown mottled
	several hundred feet"	BLACKROCK CANYON LIMESTONE Limestone, grey interbedded with minor quartzite and variegated argillite
	2,000 ±	Upper Member POCATELLO FORMATION Argillite, black, phyllitic, graphitic; with interbedded quartzite in the upper part Sandstone, siltstone, and marble, white (25')
	Scout Mountain= "several thousand feet thick"	Scout Mountain and Bannock Volcanic members Sandstone, laminated; interbedded with limestone, laminated; locally thick diamictite units; intertongues with basic porphyritic and amygdaloidal flows and pyroclastics; locally intruded by diabase
	?	Base not seen in SE Idaho; rests on Farmington Complex in Utah
		FARMINGTON COMPLEX Gneiss and amphibolite

in the axial part of the Cordilleran geosyncline of eastern Nevada-western Utah-southeastern Idaho. In the same period, only about 6,000 to 10,000 feet of equivalent materials accumulated on the Wyoming-eastern Utah shelf area. The zone of thickening between the shelf and the miogeosyncline (hinge zone) appears to have exercised an important control on structures formed later, in the Laramide and Sevier orogenies (Armstrong and Oriel, 1965).

Commencing in Jurassic time, the depositional axis shifted eastward across the hingeline zone, probably as a response to uplift and deformation in the old basin area to the west. In Cretaceous time, this wave of compressional deformation and uplift passed eastward across the hingeline zone, while the depositional axis of the Cretaceous seas migrated into Wyoming and eastern Utah, in front of the deformational zone. The major structures of this episode are an arcuate series of subparallel anticlines and synclines cut by major low-angle thrust faults. The thrust fault closest to the Preston prospect lies along the east side of the Bear River Range, and dips to the west at a low angle. The location of the root zone of this thrust relative to the prospect area is uncertain. Widely differing alternatives suggest that the older Precambrian (Pocatello) rocks are in the footwall zone, or that the thrust may actually pass beneath them. The extensive exposures of Precambrian rocks in the Bannock Range, west of Cache Valley, show low-angle shear zones. However, overturning or major thrusts have not been detected there.

The Early Cenozoic history of the Cache Valley area is poorly known, as no deposits of this age have been identified. Probably it was an upland area subjected to extensive erosion. Later, perhaps as early as late Miocene time, the onset of Basin-and-Range faulting created an extensive basin in the region. Large amounts of tuffaceous fluvial and lacustrine clays, sands and gravels were deposited here. As much as 7,000 to 8,000 feet of these sediments, referred to the Salt Lake Formation, may be preserved in some parts of Cache Valley. The tuffaceous material in this section may be derived from volcanism in the Snake River Plain (S. Oriel, 1978, oral communication).

The climax of Basin-and-Range faulting appears to have occurred in late Pliocene time. No recent faulting has been reported in Cache Valley, although there has been historic seismicity in Malad Valley, to the west. The most important structures of this period are the north-trending normal faults separating the Cache Valley graben from the Bannock and Bear River Range horst bounding it on the west and east, respectively. The displacement on each of these fault systems may be 8,000 to 10,000 feet in areas of greatest movement. Both the horsts and grabens are cut by subsidiary faults. One of the most important secondary structures

is the Little Mountain horst complex, within the Cache Valley graben. The trend of faults associated with this feature is to the northwest, oblique to the main range-front faults (plate 1). In addition, a long, poorly defined lineament has been noted on ERTS imagery (Mitchell, 1976). This feature trends east-northeast along the Bear River near Preston. The structural significance of this feature is uncertain from the data now available.

Structural lowlands formed during Basin-and-Range faulting are either closed basins, or parts of larger closed basin complexes which were covered by lakes during parts of Quaternary time. At that time, Cache Valley was occupied by an arm of Lake Bonneville into which the Bear River built a delta of silts and gravels reaching a local thickness of several hundred feet. Changes in local base-level in the Lake Bonneville-Great Salt Lake drainage system have caused the Bear River to dissect this fill and cut prominent terraces in northern Cache Valley, near the well site.

The Quaternary history of the region includes the extrusion of basalt in Gem Valley and basalt flows and rhyolite domes in the Blackfoot lava field and the Snake River Plain, to the north of Cache Valley. However, Cenozoic volcanic rocks are absent from the prospect area, with the exception of small lamprophyric intrusions in the Salt Lake Formation south of Oneida narrows, and a lava flow or sill under Cache Valley, between Cornish and Lewiston, Utah (Mitchell, 1976). Small basalt dikes of unknown age occur south of Twin Lakes Reservoir in Little Mountain and in Five-Mile Canyon, near Dayton, Idaho.

SUMMARY GEOLOGY OF BERT WINN #1 GEOTHERMAL TEST

Stratigraphy

Detailed descriptions of cuttings appear as Appendix A to this report. The Baroid mud log is appendix B. A summary of this log can be found in table 3. Rock and mineral identifications are based on detailed study with a binocular microscope.

The well commenced drilling in non-lithified gravel, silt and sand deposited during the Provo stage of Quaternary Lake Bonneville (Oriel and Platt, 1968). Sampling did not begin until a depth of 350 feet. At this point, the well had already entered Precambrian rocks. Thus, the Quaternary sediments are less than 350 feet thick. It is probable that these sediments rest directly on Precambrian rocks and that the Tertiary Salt Lake Formation is absent at this site.

From some depth shallower than 350 feet, the well continued in Precambrian metamorphic rocks to the total depth of 7,981 feet. Four main assemblages are identified (table 3). The character of these units is summarized below, in the order in which they were penetrated. It should be noted that the intervals given are drilled thickness: the dip of the rocks is unknown and thus the true stratigraphic thickness cannot be determined.

Unit 1 (less than 350 feet to 4,390± feet). This interval consists of interbedded, weakly-foliated chlorite-albite-calcite greenschist, albite-actinolite metadiabase, quartzite and gray phyllite. The metadiabase and greenschist units have a similar gamma ray log character and are readily identified on this log. Intervals containing a high percentage of phyllite are characterized by rapid alternation from high to surprisingly low resistivity in both Units I and II. The greenschist is of uncertain origin. It may be an altered basic volcanic rock, or a metadiabase in which the characteristic texture has been destroyed. Those units with a distinctly diabasic relict texture are in the intervals 730-980, 1,020-1,050, 1,140-1,250, 1,500-1,640, 1,710-1,730 and 3,390-3,520 feet. The base of the interval has been picked on the gamma ray log as being the base of the lowest thick greenschist unit, at about 4,440 feet. Below this point, phyllite and quartzite are the dominant lithologic types, greenschist is present only in minor amounts and no metadiabase was recognized.

Unit II (4,390± to below 5,585 feet). The rocks in this interval consist of interbedded, well-foliated sericite-chlorite phyllite or schist, more-or-less-graphitic gray phyllite, light-gray phyllite or

Table 3. Sunedco Bert Mann #1 Geothermal Test, Stratigraphic [illegible]

DEPTH (ft.)	LITHOLOGY	SUMMARY DESCRIPTION	AGE AND CORRELATION
	No samples	No data	Quaternary-Precambrian contact above 330'
			----?----?----?----?---
500		330 Greenschist, poorly-foliated to non-foliated (chlorite-albite-muscovite?-biotite?-quartz?) with minor phyllite and quartzite	
		730 Metadiabase(?) (albite-actinolite-chlorite?-calcite)	
1,000		980 Quartzite 1020 Metadiabase(?) 1050 Phyllite, greenschist and quartzite 1140 Metadiabase 1250 Greenschist and phyllite 1380 Phyllite and quartzite	
1,500		1600 Metadiabase 1640 Quartzite with phyllite and greenschist 1710 Metadiabase(?) 1730 Phyllite and quartzite	
2,000		1977 Greenschist, weakly foliated to non-foliated 2025 Phyllite and quartzite 2325 Greenschist (chlorite-albite-actinolite?), calcareous 2355 Quartzite and phyllite 2418 Greenschist, as above, very calcareous	
2,500		2495 Phyllite and quartzite	Unit I Greenschist (weakly foliated) Subordinate phyllite and quartzite, with several metadiabase intrusives. Scout Mountain member(?) (4,060'+)*
		2900 Greenschist, as above, with phyllite 2960 Phyllite, quartzite, and minor greenschist	
3,000		3230 Greenschist, weakly foliated, granular, very calcareous 3385 Metadiabase	
3,500		3545 Phyllite and quartzite 3630 Greenschist, weakly-foliated, with minor phyllite and quartzite and possible metadiabase 3768 Quartzite and phyllite or very fine sericite schist 3892 Greenschist(chlorite-sericite), foliated	
4,000	G G	4030 Phyllite, graphitic 4150 Greenschist, as above Phyllite and quartzite 4360 Greenschist, as above 4390	4,390'— Unit II Phyllite-Quartzite (includes graphitic phyllite/sericite schist and chlorite-sericite greenschist) Scout Mountain member? (1,210'±)*
4,500			
5,000		Quartzite and phyllite	
5,500		Phyllite, greenschist, and quartzite 5560	Boundary uncertain Unit III Marble phyllite/sericite schist and greenschist with marble and dolomite marble (270'±)*
		Lost circulation at 5,585', no returns 5,560'-5,700' 5,600'— 5700 Marble(?), dolomitic in part(?), thinly interbedded with sericite schist, phyllite and greenschist, minor quartzite 5870 5,870'—	
6,000			Unit IV Quartzite quartzite, white, vitreous, with a trace of phyllite/sericite schist partings (2,110'+)*
6,500		Quartzite, fine to medium grained, white, trace of disseminated pyrite, occasional laminae of phyllite or fine grained sericite schist, light grey	
7,000			
7,500			*Penetrated thickness. Relationship to true stratigraphic thickness unknown
		T.D. 7,981'	

fine-grained schist, and quartzite. The graphitic phyllite samples appear to correspond to intervals of low resistivity on the Schlumberger log. Lost circulation was encountered from 5,585 feet to 5,700 feet covering the contact between units II and III.

Unit III (above 5,605(?) to 5,870 feet). Calcite and dolomite marble, interbedded with minor phyllite or fine sericite schist and quartzite occur in this unit. The marble is tan to gray and finely crystalline. The dolomitic intervals contain micro-vugs. Based on the compensated neutron-formation density log, the marble-bearing unit extends at least as high as 5,605 feet. Rapid drilling rates indicate that the most porous part of the section is in the intervals 5,575-5,580, 5,580-5,592, 5,598-5,661 and 5,615-5,619 feet. The fluid losses seem most likely to have occurred in fractures, but their relationship to the marble intervals of Unit III suggests that solution cavity porosity may also be present.

Unit IV (5,820± to 7,981 feet). The deepest unit penetrated is a remarkably homogeneous white quartzite, containing a small amount of light-gray phyllite or fine-grained sericite schist, which is present as thin partings. The quartzite itself is slightly calcareous and may contain a few calcite-filled microfractures. The bottom of the unit was not reached at TD. One thin zone of partial lost circulation occurred at 7,203 feet, probably in an open fracture.

Rock types characteristic of Units I, II and III are recognizable in Sunedco C. H. Stocks 1-A, drilled in 1978, but it does not appear that Unit IV was reached in that hole. The differences in unit thickness between the holes may be due to differences in dip at the two sites. Some of the differences in lithologic detail result from the poor and unrepresentative quality of the cuttings from a large section of the Stocks well. Possible interval correlations between the two holes are shown in table 4 and plate 4, based on sample logs augmented by resistivity and gamma ray logs.

Correlations between the section seen in Bert Winn #1 and the regional Precambrian section are speculative and yield several radically different interpretations. There is a reasonable assurance that the greenschist-metadiabase sequence in Unit I is correlative with the Scout Mountain-Bannock Volcanic member of the Pocatello Formation. However, underlying Units II, III and IV do not correspond to rock types reported from the Scout Mountain member in the few areas where its basal part has been observed. Units II, III and IV also seem to be of a lower metamorphic grade and a somewhat different bulk composition than the older Precambrian of the Farmington and Green Creek complexes. They may be equivalent to quartzite and schists of the Elba Quartzite and overlying schists and marbles, seen in the Albion Range, but the relationship of

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Table 4. Comparison of Precambrian Lithologic Units, Sunedco Bert Winn #1 and C. H. Stocks 1-A.

	Bert Winn #1		C. H. Stocks 1-A	
Unit	Interval, ft	apparent thickness, ft	Interval, ft	apparent thickness, ft
I	<350 to 4,390±	>4,040	2,150± to 3,740±	>1,590
II	4,390± to >5,585	>1,195	3,740± to 5,120 or 5,260	1,380± or 1,520±
III	5,605(?) to 5,870	265±	5,120 or 5,260 to >5,340	>80± or >220
IV	5,870 to >7,981	>2,111 (base not reached)	not reached	-

the Albion Range section to the Pocatello Group has not been established. Finally, in some respects, the sequence below Unit I resembles the upper member of the Pocatello Formation and the younger Precambrian limestone and quartzite overlying it (table 2). Correlation with this sequence would indicate that the well section is overturned or overthrust! At present there appears to be no means of determining which of the several interpretations is correct; and it appears to be relatively unimportant to the geothermal prospect to resolve the question. From the point of view of reservoir potential, all of the Precambrian rocks are likely to respond equally well to fracturing under tensional stress; only marble units may show appreciable solution porosity. Therefore, no specific lithologic objectives are identified by geologic mapping or drilling here.

Structure

Bert Winn #1 is located on a buried extension of the Little Mountain horst, within the Cache Valley graben. Several normal faults have been identified on the flanks and within the block on the basis of surface geology, drainage lineaments, gravity, and subsurface data (plates 1 and 3). Direct evidence of faulting encountered in the hole is limited to lost circulation in the interval from 5,575 to 5,700 feet and at 7,203 feet. The amount of offset in these zones is uncertain, and they do not appear to represent any of the faults known or projected from other data.

GeothermEx's report on C. H. Stocks 1-A (McIntyre and Koenig, 1978) interpreted structure from that deep hole, plus several shallower gradient holes and a regional gravity survey. A re-interpretation of structure in the area has been made on the basis of the additional data from Bert Winn #1. The new interpretation (plate 3) yields a more coherent picture.

A comparison of the section in Bert Winn #1 with that in the C. H. Stocks No. 1 deep gradient hole and the C. H. Stocks 1-A deep geothermal test confirms that C. H. Stocks 1-A is separated from the other two holes by a westward-dipping fault trending slightly west of north. The displacement on this fault at the top of the Precambrian-Cenozoic unconformity is about 1,800 feet.

Correlations between the wells in the Precambrian section are too poor to indicate conclusively the nature of the pre-fault structure. As indicated in the discussion of the stratigraphic section, there is some possibility that the section in both deep tests is overturned. Low-angle shear zones reported to occur in the Bannock Range to the west have not been identified in the wells.

Neither Bert Winn #1 nor C. H. Stocks 1-A was located to test for cells of convective geothermal fluids in the major fault zones present on the west or, particularly, on the east side of the Little Mountain horst. Of the interior faults, only one dips toward the Bert Winn site (plate 3). If a dip of 60° is assigned to that fault plane, Bert Winn #1 would have intercepted it at a depth of about 10,000 feet. With a steeper dip, the intersection would be significantly deeper. There is no evidence thus far that faults within the horst are as significant to geothermal prospecting as the boundary faults are likely to be.

TEMPERATURE DATA

All of the temperature data from Bert Winn #1 have been compiled on plate 2. It can be seen from the Schlumberger temperature run #2 that the temperature increased 93°F from the surface to 200 feet, giving a shallow gradient averaging about 46°F/100 feet. The gradient from 200 to 650 feet, where a temperature of 169°F was obtained, averaged about 6°F/100 feet. The temperature at the bottom of the hole on this log run was 220°F. This yielded an average gradient of only about 0.7°F/100 feet, but this clearly was a disequilibrium condition. However, there were no clearly-defined gradient changes in the areas of lost circulation at 5,575 to 5,700 feet, 7,203 feet, or elsewhere, which indicated that no fluids strongly out of temperature equilibrium with the mud had been encountered. The gradient at the bottom of the hole, excluding the bottom-hole effect, appears to be about 0.3°F/100 feet. Again this is a disequilibrium condition.

The maximum temperature recorded at the total depth of 7,981 feet, 24 hours and 28 minutes after breaking circulation, was 220°F. Thirty-six hours and 52 minutes after breaking circulation, temperature at 7,450 feet (deepest probe penetration) was 243°F and still rising at almost 1°F/hour. A maximum stabilized temperature, after about 100 hours, is projected to be 260°-265°F. The gradient in the zone from 5,900 to 7,450 feet is highly irregular, but may average just over 2°F/100 feet. From these temperature logs, a gradient of 0.3°F/100 feet correlates to a drilling depth greater than 20,000 feet to reach a temperature of 400°F! However, with a gradient of 2°F/100 feet, drilling would have to reach 15,000 feet to obtain 400°F; and using an anticipated maximum of 260°-265°F, a gradient of nearly 2.5°F/100 feet is calculated. This yields 400°F at perhaps 12,000 feet. This may be realistic for the Bert Winn #1 site. A lesser depth to 400°F is projected for C. H. Stocks 1-A, perhaps 10,000-12,000 feet.

The low gradients below about 650 feet (that is, within the Precambrian metamorphic rocks) reflect the high thermal conductivity of those rocks. More precisely, the lower calculated gradients of the deepest section (below about 6,000 feet) reflect the extremely high conductivity of quartzite (Unit IV) relative even to greenschist, phyllite and sericite-chlorite schist (Units I and II).

It is possible that lithology would change to rocks of lower conductivity with continued depth, and that the gradient would increase correspondingly. This is especially possible if (a) the section is overturned or (b) the section is cut by low-angle thrusts. However, there is no indication that this would come at a drillable depth. Even a projection of nearby normal faults (see Structure, above) suggests a depth in excess of 10,000 feet to a possible lithologic break.

The Bert Winn #1 data, compiled on plate 3, can be compared with the curves from C. H. Stocks 1-A (McIntyre and Koenig, 1978, plate 1). Although drilling procedures and the conditions under which logging was carried out were different in the two holes, the gradient profiles are similar. However, the temperatures in Stock 1-A are 20° to 60°F hotter at comparable depths in the Precambrian. Temperature in C. H. Stocks 1-A at the time the well was suspended was 252°F at 5,050 feet. This is much closer to the minimum reservoir temperatures predicted from the geochemistry of thermal waters at Battle Creek and Squaw Hot Springs (SiO_2 = 284°-302°F; Na-K-Ca = 266°-302°F) than temperatures obtained at 7,981 feet in the Bert Winn well.

This higher temperature probably indicates that C. H. Stocks 1-A was closer to the upflow zone of a convecting thermal fluid, probably a normal fault of the Little Mountain horst (plate 3). This reinforces the suggestion that the horst-bouding faults are more attractive exploration targets than faults within the horst block. It also suggests that the fault separating C. H. Stocks 1-A from Bert Winn #1 dips westward, toward the former and away from the latter.

FORMATION FLUIDS AND GAS OCCURRENCES

No formation tests were made in this hole. Thus, no direct evidence was obtained concerning the composition of formation fluids in the lost circulation zones at 5,575 to 5,700 feet and at 7,203 feet. The daily analyses of the chloride content of the mud, made by the mud engineer, have been plotted on figure 1. These show that chloride concentration remained at less than 200 mg/l from 800 feet to about 5,500 feet. This is consistent with the low chloride concentration in the river water used to make up the mud. The concentration increased rapidly to about 1,200 mg/l across the lost circulation zone at 5,575 feet to 5,700 feet. This indicates that formation fluid with a higher chloride content than the drilling mud was entering the hole in this zone. In this regard, it should be noted that the chloride concentration in the thermal waters at Squaw and Battle Creek Hot Springs ranges from 5,048 to 7,398 mg/l, and that these concentrations are unusually high for any groundwater known in this area. Thus, it is likely that the fluids in the lost circulation zone communicate with the geothermal system feeding the springs.

Efforts were made to cement off the lost circulation zone but continued losses of 20 to 40 barrels per hour occurred while drilling the rest of the hole, indicating that the cement job was not completely successful. The continued presence of 400 to 700 mg/l of chloride ion in the mud below this zone also suggests that formation water continued to enter the hole from this zone, at least in small quantities.

A thin interval of partial lost circulation above the 20 to 40 barrel background occurred at a depth of 7,203 feet. This loss was accompanied by a slight increase of the chloride ion concentration from 500 to 700 mg/l.

Carbon dioxide gas was detected in measurable amounts in the following intevals:

7,183 feet	8,000 ppm trip gas
7,195-7,215 feet	2,000 ppm
7,277 feet	1,600 ppm trip gas
7,444 feet	35,000 ppm trip gas
7,590 feet	4,000 ppm trip gas

No gases were detected in the main zone of lost circulation at 5,575 to 5,700 feet, which corresponds to the marble and dolomite of Unit III. The CO_2 occurrences are much smaller and occur in a more restricted depth range than those encountered in the C. H. Stocks 1-A well. No H_2S was encountered in measurable concentrations while

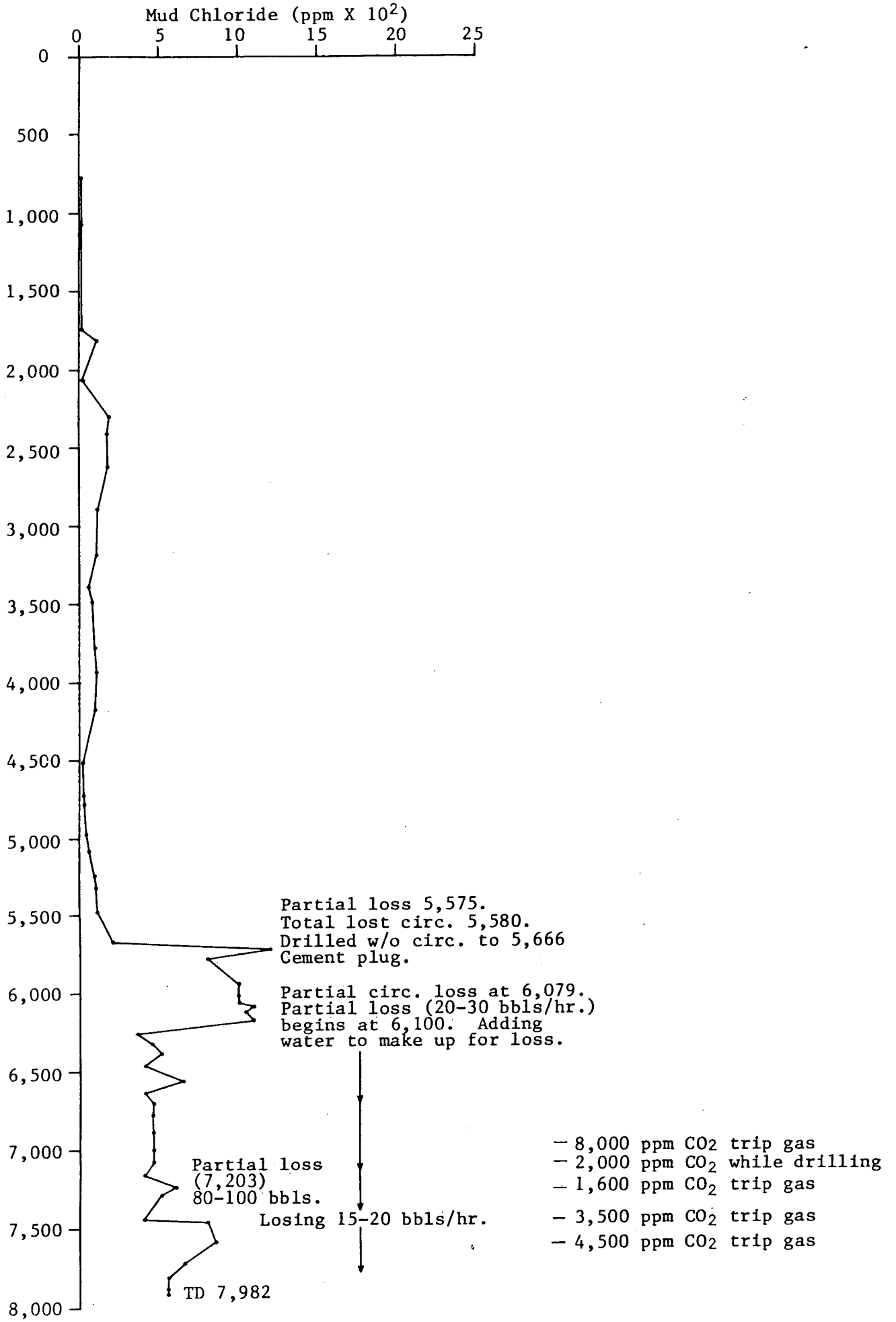

FIGURE 1. Chloride content of the drilling mud, Bert Winn #1.

drilling the Bert Winn #1 well. It is possible that the CO_2 comes from either (a) a deeper marble-dolomite horizon or (b) an open fault at some unknown depth beneath Bert Winn #1.

RELATIONSHIP OF BERT WINN #1 TO THE ORIGINAL PROSPECT CONCEPT

Originally, the Preston area was identified as a geothermal prospect on the basis of very hot, saline water issuing as springs along Battle Creek and Bear River. Later, the geothermal prospect at Little Mountain was defined by shallow and intermediate-depth temperature gradient holes and by an area of low resistivity from geoelectrical surveys. The selection of the C. H. Stocks 1-A well location was based on what was then considered to be an optimum overlap of the data from these sources. Review of the geophysical data after drilling that well resulted in the choice of the Bert Winn #1 wellsite as a better location for a test of the resistivity anomaly.

In retrospect, neither of the two deep wells appears to have tested the Preston anomaly satisfactorily. First, a reservoir of hot saline fluid with minimum temperatures above 300°F was predicted from the geochemistry of the nearby Wayland and Squaw Hot Springs waters. Second, neither well encountered conditions which could account for the low resistivity found in the surface surveys, at the depths penetrated. Additional review of the resistivity picture, using the log obtained from the Bert Winn #1, has indicated that the low resistivity feature may be present at 10,000 feet or deeper. The cause of the anomaly, whether hydrothermal clay, hot saline water or some rock character unrelated to geothermal activity, is still unknown. Third, no major range-bounding fault was intercepted in the deeper section, as indicated by the low temperature gradient, the absence of hydrothermal mineralization or H_2S gas occurrences, and the low incidence of CO_2 gas. If significant quantities of geothermal fluid are present in this area, their location has not been demonstrated by either Bert Winn #1 or C. H. Stocks 1-A.

An alternative prospect model for the Little Mountain area may have merit, analogous to the typical geothermal occurrences in the Basin and Range setting. In this model, the controlling factors are the major high-angle faults bounding the east and west sides of the Little Mountain horst. Fluids circulate upward from great depths along one or both of these faults. The fluids locally may spread laterally into fractures within the horst or into aquifers in Tertiary rocks on its lower flanks. In this way, a relatively shallow, high-gradient halo may occur around the fault conduits. The gradient and geoelectrical anomalies seen at the surface thus are offset up-dip from the fluid source at depth within the fault zones. Drilling into the shallow thermal or geoelectrical anomalies, therefore, will encounter shallow leakage phenomena, but not the higher-temperature deep source. True

depth to the anomaly is variable, depending upon fault angle and point of intersection. Wells drilled into the footwall (horst) block ultimately become low-gradient, reflecting the high conductivity of metamorphic rocks found there.

Neither C. H. Stocks 1-A nor Bert Winn #1 tested a range-front fault: Bert Winn #1 was not adequately located to accomplish this; and C. H. Stocks 1-A was terminated perhaps 2,000 to 3,000 feet short of the targeted fault intersection, for mechanical reasons (plates 2 and 3; also McIntyre and Koenig, 1978, plate 3). The higher temperatures and more-abundant CO_2 at shallower depths in C. H. Stocks 1-A suggest that this hole was closer to the horst-bounding fault that communicates with the main geothermal convective system than was Bert Winn #1. Therefore, the original prospect objective remains untested.

Temperatures of convecting fluids down-dip on this fault (or on the eastern boundary fault) probably are well in excess of 300°F. No upper temperature boundary can be established with any confidence. It may be necessary to go to 10,000 or even 12,000 feet to encounter temperatures over 400°F. Permeability, if present, is likely to be confined to the major fault zones.

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APPENDIX A

Detailed Sample Descriptions, Bert Winn #1

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Notes: A number of contaminants have been introduced into the samples from mud additives and other sources.

1. Moscovite and biotite mica were added as lost circulation material below 5,670 feet. They are much larger grains than the muscovite and biotite occurring in the phyllites of this section.

2. Nickel chloride, a bright green anti-corrosion chemical, has been added throughout the hole. It appears to dye a few cuttings bright green. This might be confused with the green chromian mica sometimes present in Precambrian rock.

3. Traces of red-brown iron oxide stain occur on a few cuttings. Most if not all of this is due to rusting pipe shavings.

4. A white, granular, soft material, often containing fragments of metal, is a ubiquitous minor constituent of the samples. The fragments are often smooth on one side as if from adhering to a pipe surface. The identity of the material is uncertain but it does not appear to be a constituent of the rock. It is not a carbonate and does not decrepitate or fuse in a flame.

DEPTH	DESCRIPTION
	(No samples above 350-370)
	(Samples from 330-350 collected by drilling crew before mud loggers arrived)
330-350	100% Greenschist (?), light to medium green-gray, non-fissile (possibly a metamorphosed silty greywacke); trace of biotite and disseminated pyrite; calcareous.
350-370	100% Greenschist (?), as above; calcareous; trace of disseminated pyrite.
370-390	100% Greenschist (?), as above; calcareous; trace of biotite and pyrite.
390-400	100% Greenschist (?), as above; calcareous; trace of pyrite veinlets. Trace of quartz vein.
410-430	100% Greenschist, part similar to above and part weakly foliated; trace of biotite and pyrite; slightly calcareous.
430-450	100% Greenschist (?), as above; non-foliated; trace of biotite and pyrite. Pinpoint vugs.
450-470	100% Greenschist (?), as above; trace of biotite and pyrite; pinpoint vugs; slightly calcareous.
470-490	100% Greenschist (?), as above; trace of biotite and pyrite; slightly calcareous.
490-510	100% Greenschist (?), as above; trace of biotite, very calcareous.
510-530	50% Greenschist (?), as above; very calcareous; trace of biotite. 50% Phyllite, light gray.
530-550	90% Greenschist, light to medium green-gray, quartzitic, calcareous, very fine grained. (Minerals are chlorite, muscovite (?), quartz, calcite, albite(?), minor biotite). Trace of pyrite and calcite in veinlets. Weakly foliated due to abundance of quartz and calcite. 10% Phyllite, light gray, very fine grained. Much lost circulation material.
550-570	90% Greenschist, as above. 10% Phyllite, as above.
570-590	95% Greenschist, as above; minor vuggy porosity. 5% Phyllite, as above.

590-610	90% Greenschist, as above; minor vuggy porosity, with pyrite or magnetic iron sulfide disseminated and in veinlets. 10% Phyllite, as above.
610-630	95% Greenschist, as above; less calcareous; trace of pyrite in veinlets. 5% Phyllite, as above.
630-650	50% Greenschist, as above; trace of pyrite veinlets. 30% Quartzite, light gray, phyllitic, very fine grained; trace disseminated pyrite. 20% Schist, light gray, very fine grained, (quartz-biotite), vuggy.
650-670	70% Greenschist, as above; very slightly calcareous, weakly foliated, with increasing biotite. 30% Phyllite, light gray, as above. Trace of Quartzite, light gray, very fine grained, as above.
670-690	Large cuttings -- mostly caving (?). 80% Greenschist, non-calcareous, quartzite, weakly foliated, with magnetic FeS in veinlets and disseminated. 20% Phyllite, as above. Trace of quartz vein.
690-710	100% Greenschist, medium green-gray, very fine grained (chlorite, quartz, albite (?), biotite) with pyrite disseminated and in veinlets with calcite.
710-730	85% *Metadiabase (?), mottled light gray and dark green, non-foliated to weakly foliated, very slightly calcareous; disseminated pyrite; trace biotite. 15% Quartzite, light gray, phyllitic, very fine grained. Trace of Phyllite, light gray, as above.
730-750	95% *Metadiabase (?), as above; non-foliated. 5% Phyllite, as above. Trace of vein quartz.
750-760	70% *Metadiabase (?), as above; slightly calcareous. 30% Quartzite, light green-gray to gray, very fine to fine grained.
760-770	70% *Metadiabase (?), as above, with increasing pyrite in veinlets. (Fibrous texture may be due to actinolite(?))

*This rock resembles basic meta-igneous rock such as "greenstone" or metadiabase.

770-780	100% *Metadiabase (?), as above.
780-790	100% *Metadiabase (?), as above, with minor disseminated pyrite. Trace of vein quartz.
790-800	100% *Metadiabase (?), as above; slightly calcareous.
800-810	100% *Metadiabase (?), as above; slightly calcareous. Trace of calcite vein material and soft crystalline white mineral (zeolite?).
810-820	100% *Metadiabase (?), as above; calcareous blebs and patches of limonite (after pyrite).
820-830	100% *Metadiabase (?), as above.
830-840	100% *Metadiabase (?), as above.
840-850	100% *Metadiabase, light green-gray and gray mottled; fibrous mineral (actinolite or tremolite), slightly calcareous; trace of oxidized pyrite.
850-860	100% *Metadiabase (?), as above; trace of pyrite. Trace of vein quartz and calcite.
860-870	100% *Metadiabase (?), as above; trace of oxidized pyrite.
870-880	100% *Metadiabase (?), as above; trace of limonite stain. Trace of calcite vein.
880-890	100% *Metadiabase (?), as above; trace of pyrite.
890-900	100% *Metadiabase (?), as above; trace of pyrite.
900-910	100% *Metadiabase (?), as above; trace of white unidentified mineral lining open cavities. Trace of vein quartz.
910-920	100% *Metadiabase (?), as above; trace of pyrite veinlets. Trace of vein quartz.
920-930	100% *Metadiabase (?), as above; slightly calcareous, white crystals lining open cavities. Trace of quartz-biotite quartzite (?).
930-940	100% *Metadiabase (?), as above; with quartz veins and cavities lined with quartz crystals.
940-950	100% *Metadiabase (?), as above; with trace of quartz and pyrite veinlets.
950-960	100% *Metadiabase (?), as above; with trace of quartz veinlets.

960-970 100% *Metadiabase (?), as above; with trace of quartz veinlets.

970-980 100% *Metadiabase (?), as above; with trace of quartz and pyrite veinlets.

980-990 40% *Metadiabase (?), as above.
30% Quartzite, medium gray, very fine grained with pyrite disseminated and in veinlets.
30% Quartzite (?), light tan-gray, very fine grained; abundant disseminated pyrite (possibly an altered tuff?).

990-1,000 50% Quartzite (?) or Meta-tuff (?) as above; with veinlets and disseminated pyrite.
30% Quartzite, medium gray, as above; pyritic.
20% *Metadiabase, as above; (caving).

1,000-1,010 Poor sample - mostly cavings (?).
70% *Metadiabase, as above (caving).
20% Quartzite, medium green, as above (Quartz-biotite), with disseminated pyrite and quartz and calcite veinlets.
10% Meta-tuff (?) or Quartzite, as above.

1,010-1,020 40% Quartzite, medium gray (with biotite), as above; pyritic.
30% *Metadiabase (?), as above (caving?).
30% Meta-tuff (?) or Quartzite, as above; pyritic.

1,020-1,030 70% *Metadiabase (?), as above; abundant biotite present, finer grained than above.
20% Quartzite, medium gray, pyritic, as above.
10% Phyllite, light gray.

1,030-1,040 90% *Metadiabase (?), fine grained, medium green-gray, (biotite-albite (?)-minor chlorite) or meta-tuff (?).
5% Quartzite, medium gray as above, with biotite and pyrite.
5% *Metadiabase, as above 990', green, medium grained.
Trace of Meta-tuff (?), light tan, aphanitic, pyritic.

1,040-1,050 60% Greenschist, light green-gray, fine grained, poor to fair fissility, scattered biotite.
30% Quartzite, light green-gray, very fine grained; trace of biotite.
5% Phyllite, light gray, fine grained.
5% Meta-tuff (?), light tan, disseminated biotite and pyrite.
Trace of Quartzite or Meta-chert, light gray, very fine grained.

1,050-1,060	60% *Metadiabase (?), fine to very fine grained, as above. 10% Greenschist, as above. 10% Quartzite, light grey, as above. 10% Phyllite, light grey, as above. 10% Quartzite(?), biotitic.
1,060-1,070	80% Quartzite, light gray and green-gray, very fine grained, scattered biotite, trace of pyrite. 10% Greenschist, as above. 10% *Metadiabase (?), as above.
1,070-1,080	70% Quartzite, light green-gray and gray, some with scattered biotite (may include meta-chert). 30% *Metadiabase (?), as above.
1,080-1,090	70% Quartzite, medium-gray, very fine grained, disseminated biotite; trace of pyrite. 20% *Metadiabase (?), caving. 10% Greenschist, as above.
1,090-1,100	50% Phyllite, medium gray, very fine grained, poor fissility. 30% Greenschist, as above. 20% Quartzite, gray, biotite-rich, as above.
1,100-1,110	50% Phyllite, as above. 30% Greenschist, as above. 20% Quartzite, light gray, green-gray, biotitic, as above.
1,120-1,130	60% Phyllite, gray, as above. 30% Greenschist, as above. 10% Quartzite, as above; with biotite.
1,130-1,140	90% Phyllite, as above. 10% Greenschist, as above.
1,140-1,150	60% *Metadiabase, dark green-gray, very fine grained, calcareous. 40% Phyllite, gray, as above.
1,150-1,160	60% *Metadiabase, as above; calcareous. 30% Phyllite, as above. 10% Quartzite, medium gray, medium grained, biotitic.
1,160-1,170	60% *Metadiabase (?), fine grained, as above; calcareous; trace of pyrite. 30% Quartzite, light green, (quartz-biotite-muscovite(?)). 10% *Metadiabase, as above 1000' (caving?).

1,170-1,180	50% *Metadiabase(?), green, as above. 40% *Metadiabase(?), black, fine grained, as above. 10% Meta-chert(?), white speckled with black biotite grains.
1,180-1,190	50% *Metadiabase(?), green, as above. 30% *Metadiabase(?), black, as above. 20% Phyllite, light gray.
1,190-1,200	80% *Metadiabase(?), green, as above. 15% *Metadiabase(?), black, as above. 5% Meta-chert, gray, pyritic.
1,200-1,210	80% *Metadiabase(?), green, as above; calcareous. 15% *Metadiabase(?), black, as above. 5% Meta-chert or Quartzite, gray, speckled with biotite; trace of pyrite. Trace of vein calcite and quartz crystals from open vugs.
1,210-1,220	60% *Metadiabase, green, as above; calcareous. 20% Phyllite, light gray. 20% Meta-chert or Quartzite, lighty gray, pyritic. Trace of vein quartz.
1,220-1,230	Poor sample. 90% *Metadiabase(?), light green, more highly altered than above; traces of biotite; calcareous. Change in Metadiabase(?) occurs about 1,220-1,230'. Metadiabase(?) may be Greenschist of a different origin. Appears to be mainly fibrous amphibole-like minerals (actinolite?). 10% Phyllite, light gray, pyritic (caving?).
1,230-1,240	90% *Metadiabase(?), light green, highly altered, traces of biotite, calcareous. Approaches greenschist appearance. 10% Phyllite, light gray, as above.
1,240-1,250	60% *Metadiabase(?), as in 1,230-1,240; very calcareous; increasing biotite. 40% Phyllite, light gray, fine grained, weak foliation, trace of microscopic white needle-like minerals; trace of pyrite.
1,250-1,260	80% Greenschist or Metadiabase(?) as in 1,240-1,250; calcareous, trace of pyrite. 20% Phyllite, gray, as above.
1,270-1,280	90% Greenschist (or Metadiabase) as above; calcareous, trace of pyrite, trace of biotite, weak foliation, vuggy. 10% Phyllite, as above.

1,280-1,290 — 50% Greenschist (or Metadiabase) as above; less calcareous.
40% Phyllite, as above; pyritic.
10% *Metadiabase, black, as above. (caving?).

1,290-1,300 — 70% Phyllite, light to medium gray, with veinlets of pyrite.
30% Greenschist (or Metadiabase), as above.

1,300-1,310 — 70% Phyllite, as above; slightly calcareous.
20% Greenschist (or Metadiabase), as above.
10% Meta-chert (or Meta-tuff replaced by silica?), trace of biotite.

1,310-1,320 — 50% Phyllite, as above.
50% Greenschist, as above; microlaminated; trace of biotite.

1,320-1,330 — 80% Phyllite, as above; slightly calcareous; pyritic.
20% Greenschist, as above.

1,330-1,340 — 60% Phyllite, as above; pyritic.
40% Greenschist with biotite, as above.

1,340-1,350 — 80% Phyllite, as above; pyritic (veinlets), calcareous.
20% Greenschist, as above.

1,350-1,360 — 90% Phyllite, as above; calcareous, trace of biotite and pyrite.
10% Greenschist, as above.

1,360-1,370 — 95% Phyllite, as above; pyrite veinlets.
5% Quartzite, medium gray, very fine grained, trace of biotite.

1,370-1,380 — 90% Phyllite, as above.
10% Quartzite, as above.

1,380-1,390 — 85% Phyllite, as above; trace of pyrite.
15% Quartzite, as above; minor biotite.

1,390-1,400 — 90% Phyllite, as above; trace of pyrite disseminated and in veinlets.
10% Quartzite, as above.
Trace of quartz-calcite-pyrite veinlets.

1,400-1,410 — 60% Phyllite, as above.
40% Quartzite, very fine grained, as above. Minor disseminated biotite and trace of pyrite.

1,410-1,420 — 90% Phyllite, as above; trace of pyrite veinlets.
10% Quartzite, as above.

1,420-1,430	80% Phyllite, as above. 20% Quartzite, as above; trace of disseminated pyrite.
1,430-1,440	90% Phyllite, gray and light green-gray, as above; slightly calcareous. 5% Quartzite, as above. 5% *Metadiabase (?), green (caving).
1,440-1,450	100% Phyllite, gray and green-gray, as above; slightly calcareous.
1,450-1,460	100% Phyllite, gray and green-gray, as above; non-calcareous; traces of biotite.
1,460-1,470	90% Phyllite, as above; with laminae of slightly coarser grained biotite. 10% Phyllite, quartzose, dark gray, very fine grained, non-foliated; scattered biotite.
1,470-1,480	50% Phyllite, light green and medium gray, as above; slightly calcareous. 50% Quartzite, medium gray, very fine grained, minor biotite and chlorite; trace of pyrite disseminated.
1,480-1,490	70% Quartzite, medium gray, fine to very fine grained; minor biotite, trace of pyrite, slightly calcareous. 30% Phyllite, light green, calcareous.
1,490-1,500	80% Quartzite, as above; fine to very fine with scattered medium grains; minor biotite; slightly calcareous. 20% Phyllite, light green and medium gray, slightly calcareous. Trace *Metadiabase (?), green and white mottled, slightly calcareous.
1,500-1,510	90% *Metadiabase (?), green and white mottled (mixture of chlorite, actinolite and albite?), calcareous, disseminated pyrite. 10% Phyllite, as above. Trace of albite (?) and quartz veinlets.
1,510-1,520	90% *Metadiabase, as above. 5% Quartzite, medium gray, with biotite, as above (caving?). 5% Phyllite, light green, as above (caving?)
1,520-1,530	95% *Metadiabase, as above; good relic textures, slightly calcareous, with white veinlets of calcite and albite (?) with trace of pyrite. 5% Quartzite, fine grained, as above (caving?).

1,530-1,540	95% *Metadiabase, as above; moderately calcareous. 5% Quartzite, as above (caving?) Trace of vein quartz.
1,540-1,550	100% Metadiabase, as above. Trace of Quartzite, as above.
1,550-1,560	100% Metadiabase, as above; calcareous. Trace of quartz vein and slickensided metadiabase.
1,560-1,570	100% Metadiabase, medium green mottled with white (actinolite-albite), slightly calcareous; good relic diabasic texture.
1,570-1,580	100% Metadiabase, as above. Trace of slickensided metadiabase.
1,580-1,590	100% Metadiabase, as above. Trace of calcite from open fractures; quartz vein fragments.
1,590-1,600	100% Metadiabase, as above. Trace of quartz and calcite vein material with trace of pyrite.
1,600-1,610	100% Metadiabase, as above. Trace of slickensided metadiabase and vein calcite.
1,610-1,620	100% Metadiabase, as above. Trace of slickensided metadiabase; calcite veinlets with hematite stain.
1,620-1,630	100% Metadiabase, as above; slightly calcareous, trace of disseminated pyrite. Trace of slickensided metadiabase, as above.
1,630-1,640	100% Metadiabase, as above. Trace of slickensided metadiabase.
1,640-1,650	60% Metadiabase, as above. 40% Quartzite, medium gray, phyllitic, very fine grained, non-foliated.
1,650-1,660	70% Quartzite, as above. 30% Metadiabase, as above (caving).
1,660-1,670	40% Phyllite, medium gray, very fine grained, poorly foliated, quartzitic (?). 30% Quartzite, phyllitic, very fine grained, as above. 30% Metadiabase, as above (caving).
1,670-1,680	60% Quartzite, light to medium gray, fine to very fine grained, scattered biotite and pyrite. 40% Phyllite, light to medium gray, weak foliation.

1,680-1,690	70% *Greenschist, light gray-green, moderately foliated, soft, moderate-sized biotite crystals scattered; trace of pyrite. *This Greenschist may be a sheared zone. 30% Quartzite, as above; with scattered biotite.
1,690-1,700	90% Quartzite, medium gray, very fine grained, micaceous with scattered biotite. 10% Greenschist, as above.
1,700-1,710	60% Quartzite, as above; scattered biotite. 40% Phyllite, medium gray, quartzitic. Trace of slickensided Phyllite.
1,710-1,720	60% Metadiabase (?), medium green, mottled with white and black (albite-chlorite-actinolite?-magnetite). 40% Quartzite, medium gray, micaceous, as above. Trace of slickensided metadiabase (?).
1,720-1,730	70% Metadiabase (?), as above; fine grained with disseminated traces of magnetic FeS and magnitite (?); moderately calcareous; biotite (?) may also be present. 20% Phyllite, as above. 10% Quartzite, as above.
1,730-1,740	70% Quartzite, medium gray, very fine grained, micromicaceous (biotite). 30% Phyllite, medium gray, slightly calcareous.
1,740-1,750	80% Quartzite, as above. 20% Phyllite, as above.
1,750-1,760	60% Quartzite, as above; slightly calcareous. 40% Phyllite, as above.
1,760-1,770	60% Phyllite, as above; slightly calcareous. 40% Quartzite, as above.
1,770-1,780	70% Quartzite, as above. 30% Phyllite, as above.
1,780-1,790	50% Quartzite, as above. 50% Phyllite, as above, quartzitic and slightly calcareous.
1,790-1,800	60% Phyllite, as above; dark gray with streaks of slightly coarser biotite; slightly calcareous. 40% Quartzite, medium to dark gray, very fine grained, as above; with slightly coarser disseminated biotite.
1,800-1,810	80% Quartzite, dark gray, fine to medium(?) grained, very micaceous, with small biotite blebs; slightly calcareous, trace of chlorite. 20% Phyllite, light to medium gray, very fine grained.

1,810-1,820	90% Quartzite, fine to medium grained(?) as above; albite(?) biotite mica, trace of chlorite, moderate pyrite deposited between grains; quartz veinlets; trace of red-brown garnet(?) and pyrrhotite(?). 10% Phyllite, as above. Trace of Chlorite Schist, moderately coarse, pyritic.
1,820-1,830	80% Quartzite, as above; trace of chlorite, pyrite and pyrrhotite(?). 20% Phyllite, as above. Trace of slickensided quartzite.
1,830-1,840	70% Quartzite, as above. Quartzite in 1,800-1,840 contains more and coarser biotite and is coarser grained than above. Metamorphic grade appears to have increased slightly at this level. 30% Phyllite, as above.
1,840-1,850	70% Phyllite, medium gray, very fine grained, slightly calcareous. 30% Quartzite, medium gray, fine grained, moderate disseminated finely crystalline biotite.
1,850-1,860	80% Phyllite, as above. 20% Quartzite, medium gray, very fine grained with scattered fine biotite, as above.
1,860-1,870	70% Phyllite, as above. 30% Quartzite, as above.
1,870-1,880	70% Phyllite, as above; trace of pyrite veinlets. 30% Quartzite, as above. Trace of calcite veinlets.
1,880-1,890	50% Phyllite, as above. 50% Quartzite, as above; trace of pyrite.
1,890-1,900	60% Phyllite, as above; trace of pyrite. 40% Quartzite, as above; trace of pyrite and calcite.
1,900-1,910	80% Phyllite, medium gray, quartzitic, very fine grained. 10% Phyllite, as above. 10% Quartzite, as above.
1,910-1,920	80% Phyllite, slightly quartzitic, as above. 20% Quartzite, as above.
1,920-1,930	60% Quartzite, medium to dark gray, fine grained, moderately abundant biotite; pyrite veinlets and films between quartz grains; calcite veinlets (similar to 1,800-1,810). 40% Phyllite, medium dark gray, very fine grained with microscopic white porphyroblasts ("spotted slate" texture).

1,930-1,940	60% Quartzite, medium gray, phyllitic, very fine grained. 40% Phyllite, as above; films of pyrite on foliation surfaces.
1,940-1,950	70% Phyllite, as above; pyrite veinlets. 30% Quartzite, fine grained, micaceous; trace of pyrite/pyrrhotite.
1,950-1,960	90% Phyllite, as above; pyrite/pyrrhotite disseminated and in veinlets. 10% Quartzite, very fine grained, as above. Trace of quartz vein.
1,960-1,970	100% Phyllite, pyritic, as above.
1,970-1,980	80% Phyllite, dark gray, finely crystalline, coarser grained biotite than above; pyritic. 20% Phyllite, medium gray, very fine grained, as above.
1,980-1,990	90% Greenschist(?), fine grained, (chlorite-albite(?)-biotite-quartz?); trace of almandite garnet?; vuggy, pinpoint crystal-lined porous areas; pyritic/pyrrhotite weakly foliated to non-foliated. 10% Phyllite, as above. Trace of quartz crystals(?) lining open fractures.
1,990-2,000	95% Greenschist(?), as above. 5% Phyllite, as above.
2,000-2,010	95% Greenschist, as above, with trace of pyrite and quartz veinlets. 5% Phyllite, as above. Trace of slickensided Greenschist.
2,010-2,020	60% Greenschist, as above; trace of pyrite/pyrrhotite. This Greenschist (1,980-2,020±) is weakly foliated. It may be altered basic volcanic rock. Mineral identifications are tentative. 30% Quartzite, medium-dark gray, fine grained, with scattered biotite. 10% Phyllite, as above. Trace of quartz and pyrite veinlets.
2,020-2,030	40% Phyllite, dark gray, very fine grained, pyritic. 40% Quartzite, as above; with fine to medium grains, phyllitic, pyritic. 20% Greenschist, as above (caving?). Trace of slickensided Phyllite.
2,030-2,040	60% Quartzite, as above; fine and medium grains, poorly sorted, scattered biotite mica, calcareous; slightly calcareous. 40% Phyllite, as above.

2,040-2,050	60% Phyllite, as above; trace of pyrite veinlets. 40% Quartzite, as above; fine and medium grained.
2,050-2,060	80% Quartzite, as above; fine and medium grained. 20% Phyllite, as above; with a trace of pyrite veinlets. Trace of Metadiabase, green and white mottled (albite-actinolite?).
2,060-2,070	90% Quartzite, as above; trace of disseminated pyrite. 10% Phyllite, as above.
2,070-2,080	95% Quartzite, as above. 5% Phyllite, as above.
2,080-2,090	70% Quartzite, as above; with minor large fragments(?) of albite. 30% Phyllite, as above; trace of pyrite veinlets.
2,090-2,100	80% Phyllite, as above; trace of pyrite. 20% Quartzite, as above.
2,100-2,110	80% Phyllite, as above; trace of pyrite. 20% Quartzite, as above.
2,110-2,120	95% Phyllite, as above. 5% Quartzite, as above.
2,120-2,130	100% Phyllite, as above. Trace of Quartzite, as above.
2,130-2,140	100% Phyllite, as above; trace of pyrite/pyrrhotite.
2,140-2,150	100% Phyllite, as above; trace of pyrrhotite.
2,150-2,160	70% Phyllite, as above; trace of pyrite. 30% Quartzite, dark grey, very fine grained, micro-micaceous; trace of disseminated pyrite and calcite.
2,160-2,170	80% Phyllite, as above. 20% Quartzite, very fine grained, as above; trace of pyrite/pyrrhotite.
2,170-2,180	90% Phyllite, as above; trace of pyrite veinlets, calcareous. 10% Quartzite, as above; slightly calcareous.
2,180-2,190	100% Phyllite, as above; slightly calcareous; trace of pyrite veinlets and blebs.
2,190-2,200	100% Phyllite, as above; trace of pyrite and quartz veinlets. Trace of Quartzite, medium grained.

2,200-2,210
80% Quartzite, medium and dark gray, very fine grained, scattered biotite and pyrite, slightly calcareous.
20% Phyllite, as above.

2,210-2,220
95% Quartzite, as above; slightly calcareous.
5% Phyllite, as above.

2,220-2,230
100% Quartzite, as above.
Trace of Phyllite, as above.

2,230-2,240
100% Quartzite, as above; very fine grained with scattered medium grains (quartz, albite, green fragments); biotite and pyrite in interstices; calcareous.

2,240-2,250
100% Quartzite, as above; trace of pyrrhotite.

2,250-2,260
60% Quartzite, as above; calcareous.
40% Phyllite, as above; calcareous.

2,260-2,270
60% Quartzite, as above; calcareous.
40% Phyllite, as above; pyritic.
Trace of albite-quartz(?)-biotite rock, very fine grained.

2,270-2,280
90% Phyllite, as above; calcareous; trace of pyrite/pyrrhotite.
10% Quartzite, as above.

2,280-2,290
90% Phyllite, medium to dark gray, slightly calcareous; veinlets of pyrite.
10% Quartzite, medium gray, very fine grained, slightly micaceous (biotite) and calcareous.
Trace of calcite veinlet.

2,290-2,300
70% Phyllite, as above.
30% Quartzite, as above.
Trace of calcite and pyrite veinlets.

2,300-2,310
80% Phyllite, as above.
20% Quartzite, as above.

2,310-2,320
80% Phyllite, as above.
15% Quartzite, as above.
5% Greenschist, light green (chlorite-actinolite).

2,320-2,330
80% Greenschist, light green to light gray, fine crystalline, very calcareous (actinolite-talc(?)-chlorite-albite?); trace of disseminated pyrite.
15% Quartzite, light gray, very fine grained, scattered biotite; pyrite/pyrrhotite veinlets; calcareous.
5% Phyllite, gray, as above (caving?).

2,330-2,340
100% Greenschist, as above; very calcareous.
Trace of Phyllite, as above; caving.

2,340-2,350	90% Greenschist, as above; very calcareous. 10% Quartzite, light gray, scattered biotite.
2,350-2,360	70% Quartzite, medium gray, phyllitic, very fine grained (silt-sized); disseminated biotite, slightly calcareous; trace of pyrite. 30% Phyllite, medium-dark gray, quartzitic, slightly calcareous, trace of pyrite.
2,360-2,370	70% Phyllite, as above; trace of pyrite. 30% Quartzite, phyllitic; silt-sized, as above.
2,370-2,380	50% Phyllite, as above; pyrite veinlets. 50% Quartzite, medium gray, very fine grained, trace of biotite, pyritic; slightly calcareous.
2,380-2,390	50% Phyllite, as above; pyrite veinlets; slightly calcareous. 50% Quartzite, very fine grained, as above; trace of biotite, calcite, pyrite.
2,390-2,400	80% Quartzite, light to medium gray, very fine grained, scattered biotite and pyrite; slightly calcareous; pyrite veinlets. 20% Phyllite, as above.
2,400-2,410	60% Quartzite, light gray, calcareous, as above; pyritic. 40% Marble(?), white, medium crystalline.
2,410-2,420	80% Greenschist, light green, actinolitic, very calcareous (or actinolitic Marble?); trace of pyrite. 15% Quartzite as in 2,390-2,400. 5% Phyllite, as above.
2,420-2,430	90% Greenschist, very calcareous, as above; or actinolitic Marble. 5% Phyllite, as above (caving). 5% Quartzite, as above (caving).
2,430-2,440	95% Greenschist or actinolitic Marble, as above. 5% Quartzite, as above (caving).
2,440-2,450	100% Greenschist, as above; very calcareous.
2,450-2,460	100% Greenschist, as above; very calcareous.
2,460-2,470	100% Greenschist, as above; very calcareous.
2,470-2,480	100% Greenschist, as above; very calcareous.
2,480-2,490	90% Greenschist, as above; very calcareous. 10% Phyllite, dark gray, trace of pyrite.
2,490-2,500	90% Phyllite, dark gray; veinlets of pyrite/pyrrhotite. 10% Greenschist, as above (caving).

2,500-2,510	80% Phyllite, as above. 15% Greenschist, as above (caving). 5% Quartzite, light gray, very fine grained; trace of disseminated pyrite.
2,510-2,520	85% Phyllite, as above. 10% Greenschist, as above (caving). 5% Quartzite, light gray, very fine grained, as above.
2,520-2,530	50% Phyllite, as above. 50% Quartzite, as above; with disseminated biotite, pyrite; grains appear to be coarser, very calcareous. Trace of Greenschist (cavings), veinlets of pyrite and calcite.
2,530-2,540	90% Quartzite, as above, light to medium gray. 10% Phyllite, as above. Trace of pyrite and Greenschist.
2,540-2,550	55% Quartzite, as above. 40% Quartzite, calcareous, white, fine to medium grained with microcrystals of biotite and occasional pyrite coatings. 5% Greenschist, as above.
2,550-2,560	60% Quartzite, as above, with trace rose to bronze tint. 35% Quartzite, calcareous, medium grained, as above. 5% Phyllite, as above.
2,560-2,570	90% Quartzite, as above, (salt and pepper-like) light gray to dark gray, abundant biotite, trace pyrite, very calcareous -- some has greenish color to it. 10% Calcite and quartz vein.
2,570-2,580	85% Quartzite, as above, some with salmon tint. 15% Quartz and calcite (vein?), white, with minor pyrite cubes. Trace of Phyllite.
2,580-2,590	85% Quartzite, calcareous, fine grained, medium gray to dark gray (salt and pepper-like), with abundant biotite. 10% Calcite or Marble, white, vein(?). 5% Quartz, white, vein(?).
2,590-2,600	85% Quartzite, as above. 15% Calcite or Marble, white, as above. Trace of Greenschist.
2,600-2,610	95% Quartzite, medium gray to dark gray, as above. 5% Calcite or Marble, white.
2,610-2,620	100% Quartzite, as above, increasing tan coloring. Trace of calcite vein material, and trace pyrite.

2,620-2,630	100% Quartzite, as above, light to medium gray. Trace of calcite vein material.
2,630-2,640	95% Quartzite, as above, mostly medium gray. 5% Marble(?), white with greenish tint.
2,640-2,650	100% Quartzite, as above, medium gray. Trace of Marble(?) or calcite vein.
2,650-2,660	100% Quartzite, as above, light to medium gray. Trace of calcite vein.
2,660-2,670	100% Quartzite, as above. Trace of pyrite.
2,670-2,680	100% Quartzite, as above; fine grained, medium gray, salt and pepper appearance, abundant biotite. Trace of pyrite.
2,680-2,690	60% Quartzite, as above; with considerable reddish (hematite?) color. 30% Calcite and Quartz, white, vein material?, some with chlorite. 10% Quartzite, gray, very fine grained, grading to Phyllite. Trace of pyrite and Greenschist.
2,690-2,700	80% Phyllite, dark gray. 10% Quartzite, as above; salt and pepper, fine grained with hematite(?) stain to very fine grained medium gray, grading into Phyllite. 10% Calcite, white, vein material. Trace of pyrite on Phyllite and Quartzite.
2,700-2,710	90% Phyllite, dark gray, micaceous, with disseminated pyrite, almost a schist. 5% Quartzite, as above; brown-stain on quartz. 5% Calcite, white, vein?
2,710-2,720	95% Phyllite, dark gray, as above; with disseminated pyrite. 5% Calcite, white. Trace of Quartzite (caving).
2,720-2,730	100% Phyllite, dark gray, graphitic, with veinlets, spots and disseminated pyrite. Trace of white calcite.
2,730-2,740	100% Phyllite, dark gray (gun metal), graphitic, with disseminated pyrite. Trace of white calcite.
2,740-2,750	90% Phyllite, dark gray, as above; graphitic. 10% Calcite, white, vein(?). Trace of pyrite coatings, clusters and disseminated.

2,750-2,760	100% Phyllite, as above; graphitic. Trace of calcite, white. Trace of pyrite, cubes, coatings, veinlets.
2,760-2,770	95% Phyllite, dark gray, graphitic, with disseminated pyrite. 5% Calcite, white. Trace of pyrite cubes and coatings.
2,770-2,780	100% Phyllite, as above; graphitic. Trace of white calcite. Trace of pyrite.
2,780-2,790	95% Phyllite, as above, graphitic. 5% Calcite, white. Trace of increasing pyrite coatings, veinlets, cubes and disseminated in Phyllite.
2,790-2,800	100% Phyllite, as above; slightly graphitic. Trace of calcite, white. Trace of pyrite, mostly disseminated. Trace of Quartzite, fine grained, calcareous; light brownish gray.
2,800-2,810	100% Phyllite, dark gray, as above. Trace of calcite, white. Trace of pyrite, veinlets, coatings.
2,810-2,820	100% Phyllite, as above; trace of pyrrhotite. Trace of calcite, white; pyrite and Quartzite.
2,820-2,830	95% Phyllite, as above. 5% Quartzite, fine grained with brownish-red stain. Trace of calcite, white; pyrite.
2,830-2,840	95% Phyllite, as above. 5% Quartzite, fine grained, calcareous, brownish stain, pyritic. Trace of calcite, white.
2,840-2,850	100% Phyllite, as above; graphitic. Trace of Quartzite, calcareous, and white calcite. Trace of pyrite.
2,850-2,860	100% Phyllite, as above. Trace of pyrite, disseminated.
2,860-2,870	100% Phyllite, as above. Trace of pyrite, calcite.
2,870-2,880	100% Phyllite, as above; graphitic, pyritic and with pyrrhotite veinlets.

2,880-2,890	70% Phyllite, as above; trace of pyrite. 30% Quartzite, medium gray, very fine grained, calcareous.
2,890-2,900	90% Phyllite, as above; graphitic. 10% Quartzite, calcareous, pyritic, greenish and brownish, very fine grained. Trace of calcite, white.
2,900-2,910	60% Greenschist, light green, very calcareous, sugary texture. 30% Phyllite, dark gray, as above; with veinlets of pyrite. 10% Quartzite, calcareous, brownish, as above.
2,910-2,920	90% Greenschist, as above; calcareous. 10% Phyllite, as above. Trace of pyrite.
2,920-2,930	90% Greenschist, as above. 10% Phyllite, as above; trace of pyrite.
2,930-2,940	90% Greenschist, as above. 5% Phyllite, as above. 5% Calcite, white.
2,940-2,950	50% Greenschist, as above; calcareous; textures vary from very fine grained to fine grained. 50% Phyllite, dark gray; trace of pyrite. Trace of calcite, white.
2,950-2,960	50% Greenschist, as above. 45% Phyllite, gray, as above; with disseminated pyrite. 5% Quartzite, medium gray, very fine grained.
2,960-2,970	90% Phyllite, dark gray, as above. 10% Greenschist, as above.
2,970-2,980	80% Phyllite, gray, as above. 15% Calcite, white. 5% Quartzite, medium gray, as above. Trace of Greenschist.
2,980-2,990	90% Phyllite, dark gray, as above. 5% Calcite, white. 5% Greenschist, as above. Trace of Quartzite, medium gray, very fine grained.
2,990-3,000	60% Greenschist, as above. 40% Phyllite, dark gray, as above. Trace of calcite, white and pyrite.

3,000-3,010
70% Phyllite, dark gray, as above.
30% Greenschist, as above.
Trace of pyrite.

3,010-3,020
95% Phyllite, dark gray, as above.
5% Greenschist, as above.

3,020-3,030
75% Phyllite, dark gray, as above.
10% Quartzite, very fine grained, medium grained.
10% Calcite, white.
5% Greenschist, as above.
Trace of pyrite cubes and coatings.

3,030-3,040
95% Phyllite, dark gray, with disseminated pyrite.
5% Calcite, white.
Trace of Greenschist.

3,040-3,050
85% Phyllite, dark gray, as above.
10% Quartzite, medium gray, very fine grained, grades to Phyllite.
5% Calcite, white.
Trace of Greenschist.
Trace of pyrite in crystals, coatings and disseminated.

3,050-3,060
80% Greenschist, as above; calcareous.
15% Phyllite, as above.
5% Quartzite, medium gray, as above.
Trace of pyrite.

3,060-3,070
85% Greenschist, light green, calcareous, mottled green and white.
10% Phyllite, dark gray, as above.
5% Quartzite, medium gray, as above.
Trace of pyrite.

3,070-3,080
70% Phyllite, as above.
30% Greenschist, as above.
Trace of Quartzite, as above.

3,080-3,090
95% Phyllite, as above.
5% Greenschist, as above.
Trace of calcite, white.

3,090-3,100
70% Phyllite, as above.
25% Greenschist, as above (very light green).
5% Calcite, white.

3,100-3,110
75% Phyllite, as above.
15% Quartzite, as above.
10% Greenschist, as above.

3,110-3,120
85% Phyllite, as above; dark gray.
5% Quartzite, as above; medium gray, very fine grained.
5% Greenschist, as above; light green and white mottled, calcareous.
5% Calcite, white.
Trace of pyrite.

3,120-3,130
60% Phyllite, as above.
40% Greenschist, as above.
Trace of pyrite and calcite, white.

3,130-3,140
60% Phyllite, as above.
35% Greenschist, as above.
5% Quartzite, as above.
Trace of calcite, white.

3,140-3,150
70% Phyllite, as above.
30% Greenschist, as above.
Trace of calcite, white; pyrite; Quartzite.

3,150-3,160
90% Phyllite, as above.
10% Greenschist, as above.

3,160-3,170
90% Phyllite, as above.
10% Quartzite, medium gray, very fine grained, as above.
Trace of Greenschist.

3,170-3,180
90% Phyllite, as above.
10% Quartzite, as above.
Trace of pyrite, Greenschist, calcite.

3,180-3,190
60% Phyllite, as above.
30% Greenschist, as above.
10% Quartzite, as above.
Trace of calcite, white; pyrite.

3,190-3,200
70% Greenschist, green and white, calcareous, as above.
30% Phyllite, dark gray, as above.

3,200-3,210
50% Phyllite, dark gray, as above.
45% Greenschist, green and white, calcareous, as above.
5% Quartzite, as above.

3,210-3,220
90% Phyllite, dark gray, as above.
5% Quartzite, as above.
5% Greenschist, as above.

3,220-3,230
80% Phyllite, as above.
10% Greenschist, as above.
10% Quartzite, medium gray, as above.

3,230-3,240
60% Greenschist, as above.
35% Phyllite, as above.
5% Quartzite, as above.
Trace of calcite, white; pyrite.

3,240-3,250	70% Greenschist, as above. 30% Phyllite, dark gray, as above.
3,250-3,260	80% Greenschist, as above, very light green to medium green. 20% Phyllite, as above. Trace of pyrite.
3,260-3,270	90% Greenschist, as above. 10% Phyllite, as above.
3,270-3,280	90% Greenschist, as above; white to medium green. 10% Phyllite, as above.
3,280-3,290	100% Greenschist, white to medium green, very calcareous.
3,290-3,300	100% Greenschist, calcareous, as above; white to medium green, containing quartz, sericite, calcite, chlorite, albite(?), and trace of pyrite. Trace of Phyllite.
3,300-3,310	100% Greenschist, calcareous, as above; white to medium green, some brownish hematite(?) stain. Trace of Phyllite; seems to be contained in schist.
3,310-3,320	100% Greenschist, calcareous, as above; with increasing amount reddish to yellowish-brown iron (?) stain; some biotite plates.
3,320-3,330	100% Greenschist, calcareous, as above; lesser amount of brown stain; trace of pyrite cubes.
3,330-3,340	100% Greenschist, calcareous, as above.
3,340-3,350	100% Greenschist, calcareous, white to very light green, some medium green, silky texture, minor pyrite crystals.
3,350-3,360	100% Greenschist, calcareous, white to light green, trace of medium green, minor gray -- possibly a stage of phyllite becoming schist; pyrite veinlets and crystals.
3,360-3,370	100% Greenschist, calcareous, as above; trace of pyrite crystals.
3,370-3,380	100% Greenschist, calcareous, as above.

3,380-3,390	40% Greenschist or Metadiabase(?), sheared, light green and gray mottled, (chlorite, albite, actinolite(?), calcite, trace of pyrite). 30% Quartzite, light gray, fine to medium grained, sericite partings; trace of pyrite and chlorite. 30% Phyllite or very fine grained sericite schist, medium gray, well foliated; trace of pyrite porphyroblasts. Trace of calcite vein or Marble, white, fine grained.
3,390-3,400	90% Metadiabase(?), medium green and white mottled, intergrowth of albite, chlorite and actinolite(?), non-foliated, slightly calcareous, trace of pyrite. 10% Phyllite - sericite Schist, as above.
3,400-3,410	95% Metadiabase, as above. 5% Phyllite-sericite Schist, as above.
3,410-3,420	100% Metadiabase, as above; slightly calcareous, trace of pyrite disseminated.
3,420-3,430	60% Metadiabase, as above. 40% Greenschist, light green to gray; very calcareous with chlorite and sericite; may be interlaminated Greenschist and Marble.
3,430-3,440	60% Greenschist, as above; very calcareous, possibly interlaminated with Marble. 40% Metadiabase, as above (caving?). Trace of quartz-calcite veinlets.
3,440-3,450	95% Metadiabase(?), green and white mottled, (albite, chlorite, actinolite(?)), slightly calcareous, non-foliated. 5% Greenschist, as above.
3,450-3,460	95% Metadiabase, as above; calcareous, trace of magnetite and pyrite disseminated. 5% Calcite vein.
3,460-3,470	100% Metadiabase, as above; non-calcareous.
3,470-3,480	100% Metadiabase, as above; slightly calcareous. Trace of calcite vein.
3,480-3,490	100% Metadiabase, as above; slightly calcareous.
3,490-3,500	100% Metadiabase, as above; non-calcareous. Trace of Quartzite, glassy, medium grained. Trace of calcite vein.
3,500-3,510	100% Metadiabase, as above; non-calcareous. Trace of calcite and quartz vein material.

3,510-3,520 100% Metadiabase, as above; trace of disseminated pyrite. Trace of calcite vein.

3,520-3,530 60% Phyllite or Sericite Schist, light gray, thinly interlaminated with marble(?); foliated, crinkled.
40% Metadiabase, as above.
Trace of calcite vein.

3,530-3,540 80% Phyllite/Sericite Schist, as above; trace of large pyrite porphyroblasts.
20% Metadiabase, as above (caving?).
Trace of calcite vein.

3,540-3,550 70% Phyllite/Sericite Schist, as above; interlaminated with
20% Quartzite, white, very fine grained, calcareous.
10% Metadiabase, as above (caving).

3,550-3,560 70% Phyllite/Sericite Schist, as above; interlaminated with
30% Quartzite, as above; pyritic.
Trace of Metadiabase (caving) and vein calcite.

3,560-3,570 90% Phyllite/Sericite Schist, as above; non-calcareous.
10% Quartzite, as above.
Trace of Metadiabase (caving).

3,570-3,580 70% Phyllite/Sericite Schist, as above, interlaminated with
30% Quartzite, as above.

3,580-3,590 70% Quartzite, as above; slightly calcareous and micaceous; trace of pyrite.
30% Phyllite/Sericite Schist, as above.

3,590-3,600 80% Quartzite, light gray-white, fine to medium grained, glassy; disseminated pyrite and trace of sericite.
20% Phyllite/Sericite Schist, as above.

3,600-3,610 80% Phyllite/Sericite Schist, as above; pyritic.
20% Quartzite, as above.
Trace of Quartz and calcite veins(?).

3,610-3,620 70% Quartzite, as above; pyritic.
30% Phyllite/Sericite Schist, as above.
Trace of vein quartz and calcite.

3,620-3,630 60% Quartzite, as above; trace of disseminated pyrite.
40% Phyllite/Sericite Schist, as above.
Trace of calcite vein.

3,630-3,640
60% Metadiabase(?), or Greenschist, green and white mottled, (albite, actinolite(?), chlorite), very calcareous.
20% Phyllite/Sericite Schist, as above.
20% Quartzite, white, glassy, trace of chlorite and pyrite.

3,640-3,650
80% Metadiabase(?) or Greenschist, as above; very calcareous.
10% Phyllite/Sericite Schist, as above.
10% Quartzite, as above.
Trace of calcite and quartz vein.

3,650-3,660
90% Greenschist, light to medium green, (chlorite, albite, actinolite(?)), very calcareous, trace of pyrite porphyroblasts.
10% Phyllite/Sericite Schist, as above.

3,660-3,670
70% Greenschist, as above; very calcareous.
30% Quartzite, white, vitreous, fine grained; slightly calcareous.

3,670-3,680
40% Quartzite, as above.
20% Greenschist, as above; calcareous.
20% Phyllite/Sericite Schist, as above.
20% Metadiabase(?), mottled green and white, as above.

3,680-3,690
60% Phyllite/Sericite Schist, as above.
30% Quartzite, as above; pyritic.
10% Greenschist, as above; calcareous.

3,690-3,700
60% Phyllite/Sericite Schist, fine grained, light to medium gray, interlaminated with
40% Quartzite, white, glassy, very fine to fine grained; trace of pyrite.
Trace of vein quartz.
Trace of Greenschist (caving).

3,700-3,710
40% Quartzite, as above; with trace of pyrite and chlorite.
40% Greenschist or Metadiabase, green and white mottled, calcareous; non-foliated.
20% Phyllite/Sericite Schist, as above.

3,710-3,720
80% Greenschist or Metadiabase, as above (albite, chlorite), calcareous; trace of pyrite.
10% Phyllite/Sericite Schist, as above, with minor chlorite.
10% Quartzite, as above.

3,720-3,730
80% Greenschist(?), as above; calcareous, (albite, chlorite).
15% Quartzite, as above; trace of pyrite.
5% Phyllite/Sericite Schist (caving).

3,730-3,740	80% Greenschist, as above; very calcareous. 15% Quartzite, as above; with chlorite. 5% Phyllite/Sericite Schist, as above.
3,740-3,750	90% Greenschist, as above; weakly foliated, calcareous. 5% Quartzite, as above; chloritic. 5% Phyllite/Sericite Schist, as above (caving).
3,750-3,760	100% Greenschist, as above; very calcareous. Trace of Phyllite/Sericite Schist, as above (caving). Trace of Quartzite, as above.
3,760-3,770	40% Greenschist, as above; calcareous. 30% Quartzite, white, glassy, fine to medium(?) grained. 30% Phyllite/Sericite Schist, very fine grained, crumbly; trace of pyrite porphyroblasts.
3,770-3,780	40% Quartzite, as above; trace of sericite and chlorite. 30% Phyllite/Sericite Schist, as above; pyritic. 30% Greenschist, as above, calcareous.
3,780-3,790	40% Quartzite, as above. 40% Greenschist, as above. 20% Phyllite/Sericite Schist, as above.
3,790-3,800	60% Quartzite, as above. 30% Phyllite/Sericite Schist, as above. 10% Greenschist, as above.
3,800-3,810	80% Quartzite, as above; trace of pyrite. 15% Phyllite/Sericite Schist, as above. 5% Greenschist, as above.
3,810-3,820	90% Quartzite, as above; trace of sericite and pyrite. 5% Phyllite/Sericite Schist, as above. 5% Greenschist, as above.
3,820-3,830	85% Quartzite, as above; trace of sericite and pyrite. 10% Phyllite/Sericite Schist, as above. 5% Greenschist, as above. (caving).
3,830-3,840	85% Quartzite, as above; trace of sericite, pyrite and bright green stain (not chlorite). 10% Greenschist, as above. 5% Phyllite/Sericite Schist, as above (caving).
3,840-3,850	100% Quartzite, as above; trace of sericite. Trace of Phyllite/Sericite Schist, as above (caving).
3,850-3,860	100% Quartzite, as above; trace of sericite and pyrite. Trace of Phyllite/Sericite Schist, as above (caving).
3,860-3,870	100% Quartzite, as above; trace of pyrite and sericite. Trace of Phyllite/Sericite Schist, as above (caving).

3,870-3,880	100% Quartzite, as above; trace of sericite, chlorite and pyrite. Trace of Phyllite/Sericite Schist, as above (caving).
3,880-3,890	60% Quartzite, as above; trace of sericite, pyrite and chlorite. 30% Greenschist, light green, (chlorite, quartz, albite(?)), pyritic, slightly calcareous. 10% Phyllite/Sericite Schist, light tan-gray, fine grained.
3,890-3,900	70% Greenschist, as above; calcareous 30% Quartzite, as above; chloritic.
3,900-3,910	80% Greenschist, as above; very calcareous. 20% Quartzite, as above.
3,910-3,920	85% Greenschist, as above; very calcareous, trace of pyrite. 10% Quartzite, as above. 5% Phyllite/Sericite Schist, medium gray, fine grained.
3,920-3,930	90% Greenschist, as above; very calcareous. 5% Quartzite, as above; trace of chlorite and pyrite. 5% Phyllite/Sericite Schist, as above.
3,930-3,940	95% Greenschist(?), green and white mottled, fine grained (albite, chlorite, actinolite(?)), calcareous, trace of pyrite; non-foliated; may be metadiabase of altered basic igneous rock. 5% Quartzite, as above.
3,940-3,950	90% Greenschist(?), as above; or Metadiabase/basic metavolcanic rock; calcareous; trace of pyrite. 10% Quartzite, as above; trace of chlorite.
3,950-3,960	85% Greenschist(?), as above; very calcareous. 15% Quartzite, as above.
3,960-3,970	80% Greenschist(?), as above; non-foliated, grading into greenschist, light green, (chlorite-sericite), well foliated. 20% Quartzite, as above.
3,970-3,980	70% Greenschist, light green-gray, fine grained (chlorite, sericite), foliated; calcareous. 20% Greenschist(?), mottled medium green and white, non-foliated, as above; calcareous; trace of pyrite. 10% Quartzite, as above.
3,980-3,990	70% Greenschist, foliated as above; slightly calcareous; trace of pyrite. 20% Greenschist(?), as above; non-foliated. 10% Quartzite, white, glassy; fine to medium grained, chloritic; trace of acicular brown crystals (cf. rutile?).

3,990-4,000	90% Greenschist, foliated, as above; moderately calcareous. 10% Greenschist(?), non-foliated, as above.
4,000-4,010	100% Greenschist, foliated, as above; slightly calcareous. Trace of Quartzite, as above.
4,010-4,020	80% Greenschist, foliated, as above. 10% Quartzite, as above; slightly calcareous. 10% Phyllite/Sericite-biotite Schist, very fine grained quartzitic.
4,020-4,030	50% Phyllite, dark gray, graphitic; crinkled; trace of pyrite. 40% Greenschist, as above. 10% Quartzite, as above, pyritic.
4,030-4,040	80% Phyllite, graphitic, as above; trace of pyrite porphyroblasts. 10% Quartzite, as above. 10% Greenschist, as above.
4,040-4,050	90% Phyllite, graphitic, as above; trace of pyrite. 5% Quartzite, as above. 5% Greenschist, as above.
4,050-4,060	85% Phyllite, dark gray, graphitic; trace of pyrite. 10% Quartzite, white, glassy, fine to medium grained. 5% Greenschist, as above.
4,060-4,070	95% Phyllite, as above, graphitic. 5% Quartzite, as above. Trace of Greenschist, as above.
4,070-4,080	80% Phyllite, as above; graphitic. 10% Greenschist, as above. 10% Quartzite, as above; trace of pyrite.
4,080-4,090	60% Quartzite, light green-gray, fine grained, laminae of Phyllite and chlorite; slightly calcareous. 20% Phyllite, graphitic, as above. 20% Greenschist, as above.
4,090-4,100	60% Greenschist(?), green and white mottled, non-foliated, (chlorite, albite, actinolite(?)), calcareous; streaked wtih chlorite. 20% Phyllite, as above. 10% Greenschist, foliated. 10% Quartzite, as above; streaked with biotite-Phyllite.

4,100-4,110	90% Greenschist, light green, moderately foliated, streaked with gray sericite schist and quartzite laminae, very fine grained; calcareous; trace of pyrite. 10% Phyllite, dark gray, as above.
4,110-4,120	95% Greenschist, as above; slightly calcareous; trace of pyrite. 5% Phyllite, as above.
4,120-4,130	95% Greenschist, as above; (albite, chlorite, muscovite, quartz(?)), slightly calcareous; trace of pyrite. 5% Phyllite, as above.
4,130-4,140	70% Greenschist, as above; slightly calcareous, trace of pyrite. 30% Phyllite, dark gray. Trace of vein quartz.
4,140-4,150	50% Greenschist, as above. 30% Phyllite, as above; slightly graphitic. 20% Quartzite, white, vitreous, fine grained. Trace of vein quartz.
4,150-4,160	85% Phyllite, black, graphitic. 10% Quartzite, as above. 5% Greenschist, as above (caving).
4,160-4,170	100% Phyllite, as above; graphitic, trace of pyrite. Trace of vein quartz.
4,170-4,180	100% Phyllite, as above; graphitic. Trace of vein quartz.
4,180-4,190	95% Phyllite, as above; graphitic. 5% Quartzite, white, glassy, fine-grained. Trace of vein quartz.
4,190-4,200	95% Phyllite, as above; graphitic; trace of pyrite. 5% Quartzite, as above.
4,200-4,210	95% Phyllite, as above; graphitic. 5% Quartzite, as above. Trace of vein quartz.
4,210-4,220	95% Phyllite, as above; graphitic; trace of pyrite. 5% Quartzite, as above. Trace of vein quartz.
4,220-4,230	50% Quartzite, light gray, very fine grained, slightly calcareous. 30% Phyllite, as above; graphitic. 20% Greenschist, medium green, weakly foliated (chlorite, albite).

4,230-4,240	80% Quartzite, gray, as above; slightly calcareous. 10% Phyllite, as above; graphitic; trace of pyrite. 10% Greenschist, as above.
4,240-4,250	60% Phyllite, as above; graphitic; trace of pyrite. 40% Quartzite, gray, as above.
4,250-4,260	90% Phyllite, as above; graphitic. 5% Greenschist, as above. 5% Vein calcite. Trace of vein quartz.
4,260-4,270	85% Phyllite, as above; graphitic; trace of pyrite. 5% Greenschist, as above; limonite stained. 5% Quartzite, as above. 5% Vein calcite.
4,270-4,280	100% Phyllite, as above; graphitic; trace of pyrite. Trace of Quartzite, as above.
4,280-4,290	100% Phyllite, as above, graphitic. Trace of Quartzite, as above.
4,290-4,300	100% Phyllite, as above; graphitic; trace of pyrite. Trace of Quartzite, as above.
4,300-4,310	100% Phyllite, as above; graphitic.
4,310-4,320	80% Phyllite, as above, medium to dark gray. 20% Quartzite, light gray, very fine grained, trace of chlorite.
4,320-4,330	60% Phyllite, medium gray, as above. 30% Quartzite, as above. 10% Greenschist, light green and grey, fine grained, (chlorite and muscovite).
4,330-4,340	70% Phyllite, as above; trace of pyrite. 20% Quartzite, as above. 10% Greenschist, as above.
4,340-4,350	40% Phyllite, as above. 40% Greenschist, light green, (chlorite and muscovite), as above; trace of pyrite. 20% Quartzite, as above.
4,350-4,360	80% Greenschist, as above; trace of pyrite. 20% Phyllite, as above. Trace of Quartzite, white, very fine grained; slightly calcareous.
4,360-4,370	60% Greenschist, as above; streaked with trace of biotite. 40% Quartzite, light green, chloritic and sericitic, calcareous.

4,370-4,380
60% Greenschist, as above; (chlorite, albite, biotite), moderately calcareous; trace of pyrite.
40% Quartzite, as above; and some glassy, fine grained Quartzite.

4,380-4,390
90% Greenschist, as above.
10% Quartzite, as above.

4,390-4,400
90% Greenschist, as above; trace of pyrite.
10% Quartzite, as above.

4,400-4,410
90% Greenschist, as above.
10% Quartzite, as above.

4,410-4,420
60% Greenschist, as above.
20% Quartzite, as above.
20% Phyllite, dark gray.

4,420-4,430
70% Greenschist, as above.
20% Quartzite, as above.
10% Phyllite, as above.

4,430-4,440
70% Quartzite, light gray, fine to very fine grained, with sericite partings.
20% Phyllite/Sericite Schist, light gray; trace of pyrite.
10% Phyllite, dark gray, as above.
Trace of Greenschist, as above (caving).

4,440-4,450
70% Quartzite, as above; trace of pyrite.
30% Phyllite/Sericite Schist, light gray, as above.

4,450-4,460
90% Quartzite, as above; trace of red brown garnet(?) and emerald green mica or chlorite(?); trace of pyrite.
10% Phyllite/Sericite Schist, light gray, as above; probably occurs as partings in quartzite.

4,460-4,470
70% Quartzite, as above; slightly calcareous.
20% Phyllite, dark gray.
10% Phyllite/Sericite Schist, light gray.
Trace of Greenschist.

4,470-4,480
60% Quartzite, as above; trace of orange-brown prismatic glassy mineral; trace of pyrite.
20% Phyllite/Sericite Schist; light gray; trace of emerald green chlorite(?).
20% Phyllite, dark gray, as above.

4,480-4,490
70% Quartzite, as above; some with trace of chlorite.
20% Phyllite, dark gray, as above.
10% Greenschist, light green, chloritic.

4,490-4,500
60% Phyllite, dark gray; trace of pyrite.
40% Quartzite, green and gray, as above.

4,500-4,510	80% Phyllite, as above; trace of pyrite and graphite(?). 20% Quartzite, green and white, fine grained; trace of pyrite.
4,510-4,520	90% Phyllite, as above; graphitic. 10% Quartzite, as above; pyritic.
4,520-4,530	90% Phyllite, as above, trace of pyrite and graphite. 10% Quartzite, as above.
4,530-4,540	80% Phyllite, as above; graphitic(?). 20% Quartzite, as above; trace of pyrite.
4,540-4,550	70% Quartzite, light gray, fine to medium(?) grained; sericite partings; pyritic. 30% Phyllite, as above.
4,550-4,560	60% Quartzite, as above. 40% Phyllite, as above.
4,560-4,570	90% Quartzite, light gray, fine to medium grained; gray sericite partings; intergranular pyrite. 10% Phyllite, dark gray; trace of pyrite porphyroblasts.
4,570-4,580	95% Quartzite, as above; trace of pyrite. 5% Phyllite, as above.
4,580-4,590	95% Quartzite, as above; trace of pyrite; abundant sericite partings. 5% Phyllite, as above.
4,590-4,600	90% Quartzite, as above; trace of pyrite; sericite partings. 10% Phyllite, as above.
4,600-4,610	90% Quartzite, as above; sericite partings. 10% Phyllite, as above.
4,610-4,620	90% Quartzite, as above; sericite partings. 10% Phyllite, as above.
4,620-4,630	95% Quartzite, as above, thin sericite and Phyllite partings; trace of pyrite. 5% Phyllite, as above.
4,630-4,640	70% Quartzite, light gray to white, glassy, fine to medium grained; slightly calcareous. 30% Phyllite, dark gray, slightly graphitic(?). Trace of vein quartz(?) (may be vitreous quartzite).
4,640-4,650	60% Quartzite, as above; trace of sericite partings and pyrite. 40% Phyllite, as above. Trace of vein quartz(?).

4,650-4,660	70% Quartzite, as above. 30% Phyllite, as above. Trace of vein quartz(?).
4,660-4,670	60% Quartzite, as above; trace of phyllite partings and pyrite. 40% Phyllite, as above. Trace of vein quartz(?).
4,670-4,680	80% Quartzite, as above; trace of pyrite. 20% Phyllite, as above.
4,680-4,690	50% Quartzite, as above. 50% Phyllite, as above.
4,690-4,700	50% Quartzite, as above 50% Phyllite, as above.
4,700-4,710	80% Phyllite, as above; trace of pyrite. 20% Quartzite, as above. Trace of Phyllite/Sericite Schist, light gray.
4,710-4,720	70% Phyllite, as above. 30% Quartzite, as above; trace of pyrite. Trace of Greenschist, light green (chlorite, sericite) and Phyllite/Sericite Schist, as above.
4,720-4,730	70% Phyllite, as above. 20% Quartzite, as above. 10% Greenschist, as above; granular, possibly quartzitic or albite-rich.
4,730-4,740	70% Phyllite, as above; trace of pyrite. 20% Quartzite, as above. 10% Greenschist, as above; granular, fine grained.
4,740-4,750	70% Phyllite, as above. 20% Greenschist, as above. 10% Quartzite, as above.
4,750-4,760	60% Phyllite, as above. 20% Quartzite, as above. 20% Greenschist, as above.
4,760-4,770	70% Phyllite, as above. 20% Quartzite, as above. 10% Greenschist, as above.
4,770-4,780	70% Phyllite, as above. 20% Greenschist, as above. 10% Quartzite, as above.

4,780-4,790	60% Phyllite, dark gray, crinkled surfaces; trace of pyrite, as above. 30% Quartzite, white to light gray, fine to medium(?) grained; trace of pyrite; slightly calcareous; as above. 10% Greenschist, light green-gray; (chlorite-sericite).
4,790-4,800	40% Phyllite, as above; pyritic. 40% Quartzite, as above; pyritic. 20% Greenschist, as above. Trace of vein quartz.
4,800-4,810	50% Quartzite, as above; trace of pyrite, slightly calcareous. 30% Phyllite, as above; trace of pyrite. 20% Greenschist, as above.
4,810-4,820	80% Quartzite, white to light gray, fine to medium grained, slightly calcareous; trace of pyrite; trace of interstitial chlorite. 10% Phyllite, as above. 10% Greenschist, as above.
4,820-4,830	80% Quartzite, as above; trace of pyrite. 15% Greenschist, as above. 5% Phyllite, as above.
4,830-4,840	90% Quartzite, as above; trace of pyrite; trace of red-pink stain (hematite?). Greenschist, as above.
4,840-4,850	90% Quartzite, as above; sericite partings; trace of pyrite and pyrrhotite. 10% Greenschist, as above. Trace of large flakes of muscovite.
4,850-4,860	50% Quartzite, as above; trace of pyrite. 50% Phyllite, black, very fine grained.
4,860-4,870	60% Phyllite, as above. 40% Quartzite, as above. Trace of Greenschist, as above.
4,870-4,880	60% Phyllite, as above. 20% Greenschist, as above. 20% Quartzite, as above.
4,880-4,890	80% Phyllite, as above; trace of pyrite. 10% Quartzite, as above. 10% Greenschist, as above.
4,890-4,900	85% Phyllite, as above. 10% Quartzite, as above. 5% Greenschist, as above.

4,900-4,910	95% Quartzite, as above; trace of sericite partings. 5% Greenschist, as above.
4,910-4,920	*Very fine cuttings. They may not be representative. 70% *Quartzite, white to light gray, fine grained; trace of pyrite; slightly calcareous; partings of fine grained biotite and muscovite. 30% Phyllite, black, very fine grained, probably in thin laminae in the quartzite.
4,920-4,930	60% *Quartzite, as above; micaceous partings. 40% Phyllite, as above.
4,930-4,940	60% *Quartzite, as above; micaceous partings. 40% Phyllite, as above.
4,940-4,950	70% *Quartzite, light gray, fine to medium grained, micaceous partings, as above. 30% Phyllite, as above; trace of pyrite.
4,950-4,960	80% *Quartzite, as above; trace of sericite partings. 20% Phyllite, as above.
4,960-4,970	80% *Quartzite, as above; trace of mica and albite. 20% Phyllite, as above.
4,970-4,980	70% *Quartzite, as above. 30% Phyllite, as above.
4,980-4,990	70% *Quartzite, as above. 30% Phyllite, as above.
4,990-5,000	60% *Quartzite, as above. 40% Phyllite, as above.
5,000-5,010	60% *Quartzite, as above; trace of pyrite. 40% Phyllite, as above.
5,010-5,020	90% *Quartzite, as above; trace of pyrite. 10% Phyllite, as above. Trace of Greenschist, as above.
5,020-5,030	95% *Quartzite, as above; trace of pyrite. 5% Phyllite.
5,030-5,040	85% *Quartzite, as above; trace of limonite stain. 15% Phyllite, as above. Trace of vein quartz.
5,040-5,050	80% *Quartzite, as above; 20% Phyllite, as above.
5,050-5,060	90% *Quartzite, as above; trace of pyrite. 10% Phyllite, as above. Trace of vein quartz.

5,060-5,070
90% *Quartzite, as above; trace of pyrite.
10% Phyllite, as above.

5,070-5,080
80% *Quartzite, as above; trace of pyrite.
20% Phyllite, as above.

5,080-5,090
50% *Quartzite, as above.
50% Phyllite, as above.

5,090-5,100
70% *Quartzite, as above.
30% Phyllite, as above.

5,100-5,110
70% *Quartzite, as above.
30% Phyllite, as above.

5,110-5,120
60% *Quartzite, white, fine grained; trace of pyrite and Phyllite/sericite partings.
40% Phyllite, dark gray to black.

5,120-5,130
60% *Phyllite, as above; trace of pyrite.
40% Quartzite, as above.

5,130-5,140
60% *Phyllite, as above.
40% Quartzite, as above.
Trace of vein quartz?

5,140-5,150
60% *Quartzite, as above.
40% Phyllite, as above.
Trace of Greenschist, light green, chlorite-sericite, very fine grained.
Trace of vein quartz.

5,150-5,160
50% *Quartzite, as above.
30% Phyllite, dark gray, as above.
20% Phyllite/Sericite Schist, light gray, very fine grained.

5,160-5,170
90% *Quartzite, white, vitreous, original grain boundaries obscure; trace of pyrite.
10% Phyllite, dark gray, as above.
Trace of Phyllite/Sericite Schist and Greenschist, as above.

5,170-5,180
85% *Quartzite, as above; trace of pyrite.
10% Phyllite/Sericite Schist, as above.
5% Phyllite, dark gray, as above.
Trace of Greenschist (chlorite-sericite-quartz).

5,180-5,190
85% *Quartzite, as above; trace of pyrite.
10% Phyllite/Sericite Schist.
5% Phyllite, dark gray.
Trace of Greenschist, as above.

5,190-5,200	75% *Quartzite, as above. 10% Phyllite/Sericite Schist, as above. 10% Phyllite, dark gray, as above. 5% Greenschist, calcareous, quartzitic?
5,200-5,210	70% *Quartzite, as above; trace of pyrite. 10% Phyllite/Sericite Schist, as above; slightly calcareous. 10% Phyllite, dark gray, as above. 10% Greenschist, slightly calcareous.
5,210-5,220	80% *Quartzite, as above; trace of pyrite. 10% Phyllite/Sericite Schist, as above. 10% Phyllite, dark gray, as above. Trace of Greenschist, as above.
5,220-5,230	90% *Quartzite, as above; trace of pyrite; slightly calcareous. 5% Phyllite/Sericite Schist, as above. 5% Phyllite, dark gray, as above. Trace of calcite in Quartzite or veinlets.
5,230-5,240	80% *Quartzite, as above; trace of pyrite; slightly calcareous. 15% Phyllite/Sericite Schist, as above. 5% Phyllite, dark gray, as above.
5,240-5,250	85% *Quartzite, as above; slightly calcareous; trace of pyrite. 5% Phyllite/Sericite Schist, as above. 5% Phyllite, dark gray, as above. 5% Greenschist, as above.
5,250-5,260	90% *Quartzite, as above; slightly calcareous. 5% Phyllite/Sericite Schist, as above. 5% Phyllite, dark gray, as above.
5,260-5,270	90% *Quartzite, as above; slightly calcareous. 5% Phyllite/Sericite Schist, as above. 5% Phyllite, dark gray, as above.
5,270-5,280	80% Quartzite, as above; trace of pyrite; locally calcareous; trace of biotite. 10% Phyllite, dark gray, as above; pyritic. 5% Phyllite/Sericite Schist, as above. 5% Greenschist, as above.
5,280-5,290	80% Quartzite, as above; trace of pyrite. 15% Phyllite, dark gray, as above. 5% Phyllite/Sericite Schist, as above. Trace of Greenschist, as above.

5,290-5,300 Very fine cuttings. Probably not representative.
80% Quartzite, as above.
10% Phyllite, dark gray, as above.
10% Phyllite/Sericite Schist, as above.
Trace of Greenschist, as above.

5,300-5,310 60% Quartzite, as above; with disseminated red-brown biotite(?); trace of limonite stain; trace of pyrite.
20% Phyllite, dark gray, as above.
20% Phyllite/Sericite Schist, as above.

5,310-5,320 80% Quartzite, as above; trace of limonite stain and pyrite.
10% Phyllite, dark gray, as above.
10% Phyllite/Sericite Schist, as above.
Trace of emerald green Sericite Schist and large muscovite flakes (green is probably corrosion inhibitor).

5,320-5,330 80% Quartzite, as above; slightly calcareous.
10% Phyllite, dark gray, as above.
10% Sericite Schist/Phyllite, as above.
Trace of emerald green Sericite Schist, as above (green is probably corrosion inhibitor).

5,330-5,340 90% Quartzite, as above; sericite partings; trace of pyrite.
5% Phyllite/Sericite Schist, as above.
5% Phyllite, dark gray, as above.
Trace of emerald green Sericite Schist, as above (green is probably corrosion inhibitor).

5,340-5,350 90% Quartzite, as above.
10% Phyllite/Sericite Schist, as above.
Trace of emerald green Sericite Schist, (green is probably corrosion inhibitor).

5,350-5,360 95% Quartzite, as above.
5% Phyllite/Sericite Schist, light gray mottled with light emerald green, as above (green is probably corrosion inhibitor).

5,360-5,370 80% Quartzite, white, vitreous, grain size difficult to determine; as above; trace of sericite partings and disseminated pyrite.
20% Phyllite/Sericite Schist, light gray, fine grained, as above.
Trace of emerald green mottled Sericite Schist, as above (green is probably corrosion inhibitor).

5,370-5,380
80% Quartzite, as above; slightly calcareous; trace of pyrite.
20% Phyllite/Sericite Schist, as above; muscovite and trace of chlorite.
Trace of increasing light emerald green coloration in schist (probably green corrosion inhibitor).

5,380-5,390
80% Quartzite, as above; slightly calcareous; trace of white feldspar(?).
20% Phyllite/Sericite Schist, as above; trace of chlorite.
Trace of emerald green spotted Sericite Schist.

5,390-5,400
80% Quartzite, as above; slightly calcareous.
10% Phyllite, dark gray, as above.
10% Phyllite/Sericite Schist, as above.
Trace of emerald green Sericite Schist (probably corrosion inhibitor).

5,400-5,410
80% Quartzite, as above; trace of pyrite.
10% Phyllite, dark gray, as above.
10% Phyllite/Sericite Schist, as above.
Trace of emerald green Sericite Schist (probably corrosion inhibitor).

5,410-5,420
70% Quartzite, as above; trace of pyrite and limonite pseudomorphs after pyrite; limonite stain.
20% Phyllite/Sericite Schist, limonite stain, as above.
10% Phyllite, dark gray, as above; trace of pyrite.

5,420-5,430
60% Phyllite/Sericite Schist, as above; trace of chlorite and pyrite.
40% Quartzite, as above; trace of pyrite.
Trace of Phyllite, dark gray, as above.

5,430-5,440
60% Phyllite/Sericite Schist, as above; trace of pyrite and chlorite.
40% Quartzite, as above; slightly calcareous.
Trace of Phyllite, dark gray.

5,440-5,450
60% Phyllite/Sericite Schist, as above; light tan-gray, fine grained, well foliated, crinkled; trace of pyrite.
40% Quartzite, white, vitreous, some is very fine to fine grained, other lacks visible grains; trace of mica partings and pyrite; slightly calcareous.
Trace of emerald green Sericite Schist.

5,450-5,460
85% Phyllite/Sericite Schist, as above; trace of pyrite.
15% Quartzite, as above.
Trace of emerald green Sericite Schist.

5,460-5,470	85% Phyllite/Sericite Schist, as above; trace of pyrite. 15% Quartzite, as above; slightly calcareous.
5,470-5,480	40% Phyllite/Sericite Schist, as above; trace of pyrite. 20% Greenschist, dark green, fine grained, (chlorite-sericite(?)). 20% Phyllite/Schist, medium gray (sericite-biotite). 20% Quartzite, as above; slightly calcareous.
5,480-5,490	40% Greenschist, as above. 20% Phyllite/Sericite Schist, as above; trace of pyrite. 20% Phyllite/schist, medium gray, as above. 20% Quartzite, as above. Note that the three types of Phyllite-Sericite Schist-Greenschist appear to intergrade with each other.
5,490-5,500	60% Greenschist, as above. 20% Phyllite/Sericite Schist, as above. 10% Phyllite/Schist, medium gray, as above. 10% Quartzite, as above.
5,500-5,510	50% Greenschist, as above; trace of pyrite. 30% Quartzite, as above. 20% Phyllite/Sericite Schist, as above; trace of pyrite.
5,510-5,520	40% Phyllite/Sericite Schist, as above. 30% Greenschist, as above. 30% Quartzite, as above; trace of pyrite and chlorite.
5,520-5,530	40% Phyllite/Sericite Schist, as above. 30% Greenschist, as above. 30% Quartzite, as above.
5,530-5,540	40% Greenschist, as above. 30% Phyllite/Sericite Schist, as above. 30% Quartzite, as above; calcareous.
5,540-5,550	50% Phyllite/Sericite Schist, as above. 30% Greenschist, as above. 20% Quartzite, as above.
5,550-5,560	50% Phyllite/Sericite Schist, as above. 30% Quartzite, as above. 20% Greenschist, as above.
5,560-5,570	N.S. Lost circulation at 5,585. Added lost circulation material and drilled ahead with partial returns, bypassing shakers to 5,666.
5,570-5,580	N.S.
5,580-5,590	N.S.
5,590-5,600	N.S.

5,600-5,610 N.S.

5,610-5,620 N.S.

5,620-5,630 N.S.

5,630-5,640 N.S.

5,640-5,650 N.S.

5,650-5,660 N.S.

5,660-5,670 Drilled to 5,666. Set cement plugs. Drilled out cement and drilled to 5,713 with partial returns. Poor quality sample.
30% Quartzite, white, fine grained, some with abundant calcite cement in patches; or some grains of marble(?).
30% Phyllite/Sericite Schist, light gray.
30% Calcite or Marble, white, fine grained, granular.
10% Cement.
Trace of Phyllite, dark gray.
Trace of Greenschist, light green (chlorite-sericite).

5,670-5,680 N.S. Drilling without returns.

5,680-5,690 N.S. Set cement plug. Drilled out cement but apparently drilled off the plug.

5,690-5,700 N.S.

5,700-5,710 40% Cement.
30% Marble(?), very fine crystalline, sugary, microvugs; calcite and dolomite(?); trace of pyrite.
20% Phyllite, medium to dark gray.
10% Quartzite, white, vitreous, or vein quartz.
Trace of Greenschist (chlorite-sericite).

5,710-5,720 40% Cement.
30% Phyllite, dark gray, as above.
20% Marble(?), calcite/dolomite(?), as above.
10% Quartzite or Quartz, as above.

5,720-5,730 30% Marble(?), as above; dolomite(?)/calcite.
30% Phyllite, dark gray, as above.
20% Phyllite/Sericite schist, light gray.
20% Quartzite or vein quartz, as above.

5,730-5,740 50% Marble(?) as above; (dolomite?/calcite), sandy(?).
20% Phyllite/Sericite Schist, as above.
20% Quartzite or Quartz, as above.
10% Phyllite, dark gray, microlaminated with Quartzite Siltstone.
Trace of Greenschist, as above.

5,740-5,750
40% Marble(?), as above; (dolomite(?)/calcite).
30% Quartzite or Quartz, as above.
20% Phyllite, dark gray, as above.
10% Phyllite/Sericite Schist, as above.

5,750-5,760
60% Marble(?), as above; (calcite/dolomite(?)).
20% Phyllite/Sericite Schist, as above.
10% Quartzite, as above.
10% Phyllite, dark gray, as above.
Trace of Greenschist, as above.

5,760-5,770
60% Marble(?), as above; (calcite/dolomite(?)).
20% Phyllite/Sericite Schist, as above.
10% Phyllite, dark gray, as above.
10% Greenschist, as above
Trace of Quartzite, as above.

5,770-5,780
30% Phyllite/Sericite Schist, as above.
30% Marble(?). as above; (calcite).
20% Greenschist, as above.
20% Phyllite, dark gray.
Trace of cement.

5,780-5,790
40% Marble(?), as above; (calcite and minor sericite and chlorite).
30% Phyllite/Sericite Schist, as above.
20% Greenschist, as above.
10% Phyllite, dark gray, as above.

5,790-5,800
50% Greenschist,as above (chlorite-sericite) with calcareous laminations; trace of pyrite.
40% Marble, as above; trace of pyrite.
10% Phyllite/Sericite Schist, as above.

5,800-5,810
50% Marble, as above; mainly calcite.
50% Greenschist, as above; interlaminated with marble.

5,810-5,820
50% Marble, as above.
30% Greenschist, as above.
20% Phyllite/Sericite Schist, as above.
Trace of vein quartz.
Trace of Phyllite, dark gray.

5,820-5,830
60% Marble, as above.
20% Greenschist, as above.
20% Phyllite/Sericite Schist, as above.
Trace of Marble, medium gray, fine crystalline, trace of gray mica, pyrite.

5,830-5,840
40% Marble, gray, fine crystalline, as above.
30% Marble, white, as above.
20% Phyllite/Sericite Schist, as above.
10% Greenschist, as above.

5,840-5,850	40% Marble, white, as above. 20% Marble, gray, as above. 30% Phyllite/Sericite Schist, as above. 10% Greenschist, as above. Trace of vein quartz.
5,850-5,860	60% Marble, white, as above; dolomitic(?); trace of pyrite. 40% Phyllite/Sericite Schist, as above. Trace of vein quartz.
5,860-5,870	40% Marble, medium gray, calcitic, as above. 30% Marble, white, dolomitic, as above. 30% Phyllite/Sericite Schist, as above.
5,870-5,880	30% Marble, medium gray, as above. 20% Marble, white, dolomitic, as above. Minerals in the Marble(?) 5,660± to 5,880 are difficult to identify. Calcite is present in varying abundance. Quartz and dolomite are also probably present. 30% Quartzite, white, vitreous, fine to medium grained. 15% Phyllite/Sericite Schist, as above. 5% Greenschist, light green (sericite-chlorite).
5,880-5,890	70% Quartzite, as above; trace of interstitial pyrite. 20% Marble, medium gray, as above. 10% Phyllite/Sericite Schist, as above. Trace of Greenschist, as above.
5,890-5,900	50% Quartzite, as above. 30% Marble, as above. 10% Phyllite, dark gray. 10% Phyllite/Sericite Schist, as above. Trace of Greenschist, as above.
5,900-5,910	80% Quartzite, as above; trace of pyrite. 10% Marble, as above; dolomitic. 5% Phyllite, dark gray, as above. 5% Greenschist, as above.
5,910-5,920	60% Quartzite, as above; trace of pyrite. 20% Marble, as above. 10% Phyllite, dark gray, as above. 10% Greenschist, as above.
5,920-5,930	85% Quartzite, as above. 10% Phyllite/Sericite Schist, as above. 5% Marble, as above.
5,930-5,940	90% Quartzite, as above; trace of pyrite. 5% Phyllite/Sericite Schist, as above. 5% Marble, as above.

5,940-5,950	90% Quartzite, as above. 5% Marble, as above. 5% Phyllite/Sericite Schist, as above. Trace of Greenschist, as above.
5,950-5,960	95% Quartzite, as above; trace of pyrite. 5% Phyllite, dark gray, as above.
5,960-5,970	95% Quartzite, as above. 5% Phyllite/Sericite Schist, as above.
5,970-5,980	90% Quartzite, as above. 10% Phyllite/Sericite Schist, as above.
5,980-5,990	95% Quartzite, as above; trace of pyrite. 5% Phyllite/Sericite Schist, as above. Trace of Greenschist, as above.
5,990-6,000	95% Quartzite, as above. 5% Phyllite/Sericite Schist, as above.
6,000-6,010	95% Quartzite, as above. 5% Phyllite/Sericite Schist, as above.
6,010-6,020	90% Quartzite, as above. 10% Phyllite, dark gray, probably partings in quartzite.
6,020-6,030	85% Quartzite, as above; trace of pyrite. 15% Phyllite, dark gray, as above.
6,030-6,040	95% Quartzite, white, vitreous, fine to medium grained; trace of interstitial pyrite; slightly calcareous. 5% Phyllite/Sericite Schist, light to medium gray. Trace of Marble, light to medium gray, fine grained.
6,040-6,050	95% Quartzite, as above. 5% Phyllite/Sericite Schist, as above. Trace of Greenschist (chlorite-sericite), as above.
6,050- 6,060	90% Quartzite, as above. 10% Phyllite/Sericite Schist, as above.
6,060-6,070	95% Quartzite, as above. 5% Phyllite/Sericite Schist, as above. Trace of Marble, as above.
6,070-6,080	75% Quartzite, as above. 5% Cement (caving). 5% Greenschist, as above. 5% Phyllite/Sericite Schist, as above. Trace of Marble, as above.

6,080-6,090	80% Quartzite, as above. 10% Phyllite, dark gray, as above. 5% Phyllite/Sericite Schist, as above. 5% Marble, as above.
6,090-6,100	90% Quartzite, as above. 5% Phyllite, dark gray, as above. 5% Phyllite/Sericite Schist, as above.
6,100-6,110	85% Quartzite, as above. 10% Phyllite/Sericite Schist, as above. 5% Greenschist, light green (chlorite-sericite).
6,110-6,120	85% Quartzite, as above. 5% Phyllite, dark gray, as above. 5% Phyllite/Sericite Schist, as above. 5% Greenschist, as above. Trace of Marble, medium gray, as above.
6,120-6,130	90% Quartzite, as above. 5% Phyllite, dark gray, as above. 5% Phyllite/Sericite Schist, as above.
6,130-6,140	85% Quartzite, as above. 10% Phyllite, dark gray, as above. 5% Phyllite/Sericite Schist, as above. Trace of Marble, gray and white. Trace of Greenschist, as above.
6,140-6,150	90% Quartzite, as above. 10% Phyllite, medium gray. Trace of Greenschist, as above.
6,150-6,160	90% Quartzite, white, vitreous, slightly calcareous, as above (but with some medium and coarse grained). 10% Phyllite, light and medium gray, as above. Trace of Greenschist, as above.
6,160-6,170	95% Quartzite, as above. 5% Phyllite, as above.
6,170-6,180	95% Quartzite, as above. 5% Phyllite/Sericite Schist, light gray. Trace of Greenschist, as above.
6,180-6,190	100% Quartzite, as above; trace of pyrite. Trace of Greenschist, as above. Trace of Phyllite, dark grey.
6,190-6,200	100% Quartzite, white, as above; with trace of pyrite. Trace of Phyllite, Greenschist, and lost circulation material.

6,200-6,210 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite, dark gray, as above.
Trace of Greenschist, Sericite Schist.

6,210-6,220 100% Quartzite, as above; trace of pyrite cubes.
Trace of Sericite Schist, as above.
Trace of Phyllite and Greenschist; as above.

6,220-6,230 100% Quartzite, as above.
Trace of Sericite Schist, as above.
Trace of Greenschist, as above.

6,230-6,240 100% Quartzite, as above.
Trace of Sericite Schist, as above.

6,240-6,250 100% Quartzite, as above.
Trace of Sericite Schist, as above.
Trace of calcite and pyrite.

6,250-6,260 100% Quartzite, as above; with trace of pyrite.
Trace of Sericite Schist, as above.
Trace of Phyllite, as above.

6,260-6,270 100% Quartzite, as above.
Trace of Sericite Schist, as above.
Trace of Greenschist, Phyllite, and pyrite.

6,270-6,280 100% Quartzite, as above.
Trace of Sericite Schist, as above.
Trace of pyrite, Phyllite, and Greenschist.

6,280-6,290 100% Quartzite, as above.
Trace of Schist, Greenschist, and Phyllite.

6,290-6,300 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite, Sericite Schist, and Greenschist.

6,300-6,310 100% Quartzite, as above.
Trace of Phyllite, dark gray, as above.
Trace of Greenschist, Sericite Schist.

6,310-6,320 100% Quartzite, as above; trace of pyrite.
Trace of Serecite Schist and Phyllite, as above.

6,320-6,330 100% Quartzite, as above.
Trace of Sericite Schist/Phyllite and Greenschist, calcite.

6,330-6,340 100% Quartzite, white, as above.
Trace of Sericite Schist/Phyllite and Greenschist, as above.

6,340-6,350 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist and Greenschist, as above.

6,350-6,360 — 100% Quartzite, as above.
Trace of Sericite Schist/Phyllite and Greenschist, as above.

6,360-6,370 — 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist, as above.
Trace of pyrite, calcite and Greenschist.

6,370-6,380 — 100% Quartzite.
Trace of Phyllite, Sericite Schist and Greenschist; contaminated with lost circulation materials and trace of metal filings.

6,380-6,390 — 100% Quartzite, as above.
Trace of Phyllite, Sericite Schist, as above; contaminated with lost circulation material and metal fragments, as above.

6,390-6,400 — 100% Quartzite, as above.
Trace of Sericite Schist, Greenschist and Phyllite; contaminated with lost circulation material and metal fragments.

6,400-6,410 — 100% Quartzite, as above.
Trace of Sericite Schist/Greenschist and Phyllite.
Trace of white, very soft, granular, "slickensided", origin?

6,410-6,420 — 100% Quartzite, as above.
Trace of Sericite Schist, white, as above.
Trace of Phyllite and Greenschist, as above.
Trace of white powdery, very soft mineral, origin(?).

6,420-6,430 — 100% Quartzite, as above.
Trace of Sericite Schist, white, as above.
Trace of Phyllite/Greenschist, as above.
Trace of white, powdery mineral, as above.

6,430-6,440 — 100% Quartzite, as above.
Trace of Sericite Schist, as above.
Trace of Greenschist, as above.
Trace of soft, white mineral, as above.
Trace of Phyllite.
Contaminated with lost circulation material.

6,440-6,450 — 100% Quartzite, as above.
Trace of Sericite Schist/Phyllite and soft, white mineral, as above.

6,450-6,460 — 100% Quartzite, as above.
Trace of Sericite Schist/Phyllite and Greenschist.
Trace of soft, white material.
Very dirty sample, with abundant lost circulation material. Mudloggers said it was collected after the trip. (6,454)

6,460-6,470	100% Quartzite, white, as above. Trace of Sericite Schist/Phyllite. Trace of soft, white mineral.
6,470-6,480	100% Quartzite, white, as above. Trace of Sericite Schist/Phyllite. Trace of soft, white mineral.
6,480-6,490	100% Quartzite, as above. Trace of soft, white mineral. Trace of Sericite Schist/Phyllite.
6,490-6,500	100% Quartzite, white, vitreous, fine grained, as above. Trace of Phyllite/Sericite Schist, as above. Trace of soft, white, granular mineral aggregate with microscopic veinlet of pyrite(?). Trace of cement, soft.
6,500-6,510	95% Quartzite, as above; trace of pyrite. 5% Phyllite/Sericite Schist, as above. Trace of cement and lost circulation material.
6,510-6,520	100% Quartzite, as above. Trace of Phyllite/Sericite Schist, as above. Trace of soft, white mineral, granular, slickensided, as above.
6,520-6,530	100% Quartzite, as above. Trace of Phyllite/Sericite Schist, dark gray Phyllite and Marble; calcite. Trace of white, granular, slickensided, as above (origin?). Trace of cement.
6,530-6,540	100% Quartzite, as above. Trace of Phyllite/Sericite Schist, gray Phyllite, as above. Trace of white, granular mineral (origin?).
6,540-6,550	95% Quartzite, as above; trace of pyrite. 5% Phyllite/Sericite Schist, as above. Trace of Greenschist and Phyllite, dark gray, as above.
6,550-6,560	100% Quartzite, as above. Trace of Phyllite/Sericite Schist, Phyllite, gray; and Greenschist, as above. Trace of cement.
6,560-6,570	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; and Greenschist, as above. Trace of white, granular, "mineral", as above; appears to be coating metal shavings.
6,570-6,580	95% Quartzite, as above; trace of pyrite. 5% Phyllite/Sericite Schist, as above. Trace of Phyllite, dark gray; Greenschist; calcite.

6,580-6,590 — 95% Quartzite, as above.
5% Phyllite/Sericite Schist, as above.

6,590-6,600 — 95% Quartzite, as above.
5% Phyllite/Sericite Schist, as above.

6,600-6,610 — 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist, as above.
Trace of white granular "mineral", as above.

6,610-6,620 — 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite/Sericite Schist, as above.

6,620-6,630 — 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist, as above.

6,630-6,640 — 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite/Sericite Schist; Phyllite, dark gray, as above.

6,640-6,650 — 95% Quartzite, as above; trace of pyrite.
5% Phyllite/Sericite Schist, as above.
Trace of Phyllite, dark gray; Greenschist; calcite.

6,650-6,660 — 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist, Greenschist.
Much lost circulation material (fiber, scrap mica).

6,660-6,670 — 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist; Phyllite, gray; cement.

6,670-6,680 — 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite/Sericite Schist, Greenschist, calcite.

6,680-6,690 — 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist, Greenschist, calcite.

6,690-6,700 — 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist; Phyllite, gray; calcite.

6,700-6,710 — 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite/Sericite Schist; Phyllite, gray; calcite.

6,710-6,720 — 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite/Sericite Schist; Phyllite, gray; calcite.

6,720-6,730 — 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite/Sericite Schist; calcite.

6,730-6,740 — 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist; Phyllite, gray; calcite.

6,740-6,750	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Greenschist; Phyllite, dark gray.
6,750-6,760	100% Quartzite, as above. Trace of Phyllite/Sericite Schist, as above.
6,760-6,770	100% Quartzite, as above. Trace of Greenschist and Phyllite/Sericite Schist; calcite.
6,770-6,780	100% Quartzite, as above; trace of pyrite. Trace of Quartzite, very fine, biotite rich; Phyllite/Sericite Schist and Greenschist; calcite.
6,780-6,790	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
6,790-6,800	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
6,800-6,810	100% Quartzite, as above. Trace of Phyllite, gray; calcite.
6,810-6,820	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Greenschist, as above.
6,820-6,830	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Phyllite, gray; calcite.
6,830-6,840	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
6,840-6,850	100% Quartzite, as above; trace of pyrite. Trace of Greenschist; Phyllite/Sericite Schist; calcite.
6,850-6,860	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
6,860-6,870	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
6,870-6,880	Poor sample -- cuttings are sand size. 100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Greenschist; calcite.

6,880-6,890	100% Quartzite, as above. Trace of Phyllite, dark gray; calcite.
6,890-6,900	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; Quartzite, very fine grained, biotite-rich; Marble, light gray; calcite.
6,900-6,910	100% Quartzite, as above; trace of pyrite. Trace of Greenschist; Phyllite/Sericite Schist; calcite.
6,910-6,920	100% Quartzite, as above. Trace of Phyllite, dark gray; Phyllite/Sericite Schist; calcite.
6,920-6,930	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
6,930-6,940	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
6,940-6,950	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Phyllite, gray, pyritic.
6,950-6,960	100% Quartzite, as above. Trace of Quartzite with sericite partings.
6,960-6,970	100% Quartzite, as above; trace of pyrite; occasional clasts are pale milky-blue. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
6,970-6,980	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
6,980-6,990	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
6,990-7,000	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
7,000-7,010	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
7,010-7,020	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist, spotted with green (contamination from nickel chloride anti-corrosion chemical?).
7,020-7,030	100% Quartzite, as above. Trace of Phyllite/Sericite Schist, as above, with trace of emerald green contamination(?); Phyllite, dark gray; Greenschist.

7,030-7,040	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,040-7,050	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; trace of pyrite; calcite.
7,050-7,060	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Quartzite with biotite; Phyllite, dark gray; calcite.
7,060-7,070	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,070-7,080	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,080-7,090	100% Quartzite, as above; white, glassy, slightly milky; fine to medium and possibly coarse grains, fair to poor sorting(?); slightly calcareous.
7,090-7,100	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
7,100-7,110	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Greenschist; Metadiabase (caving).
7,110-7,120	100% Quartzite, as above. Trace of Sericite Schist, white, very finely crystalline; probably laminations in quartzite.
7,120-7,130	95% Quartzite, as above. 5% Phyllite/Sericite Schist, white yellow-tan, as above.
7,130-7,140	100% Quartzite, as above. Trace of Phyllite/Sericite Schist, as above.
7,140-7,150	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist interlaminated in Quartzite; calcite.
7,150-7,160	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist, as above.
7,160-7,170	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,170-7,180	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
7,180-7,190	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.

7,190-7,200 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist; biotite-quartzite, very fine grained.

7,200-7,210 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite/Sericite Schist; Greenschist; calcite.

7,210-7,220 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist; Greenschist; calcite.

7,220-7,230 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite/Sericite Schist; Greenschist; calcite.

7,230-7,240 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist.
Trace of bright green stain ($NiCl_3$?).

7,240-7,250 100% Quartzite, as above; trace of pyrite
Trace of Phyllite/Sericite Schist, calcite.

7,250-7,260 95% Quartzite, as above.
5% Phyllite/Sericite Schist, as above.

7,260-7,270 95% Quartzite, as above.
5% Phyllite/Sericite Schist, as above.

7,270-7,280 95% Quartzite, as above.
5% Phyllite/Sericite Schist, as above.
Trace of Marble, gray; Phyllite, dark gray; Greenschist (caving).

7,280-7,290 95% Quartzite, as above.
5% Phyllite, dark gray, probably as thin interbeds in Quartzite.
Trace of Phyllite/Sericite Schist; Greenschist; calcite.

7,290-7,300 Poor, very fine cuttings.
100% Quartzite, as above.
Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.

7,300-7,310 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.

7,310-7,320 100% Quartzite, as above; trace of pyrite.
Trace of Phyllite/Sericite Schist; Phyllite, dark gray; Quartzite, fine grained with abundant biotite; calcite.

7,320-7,330 100% Quartzite, as above.
Trace of Phyllite/Sericite Schist; calcite.

7,330-7,340	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
7,340-7,350	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,350-7,360	95% Quartzite, as above. 5% Phyllite/Sericite Schist, as above; trace of pyrite; calcite.
7,360-7,370	100% Quartzite, as above. Trace of Phyllite/Sericite Schist interlaminated in the Quartzite; calcite.
7,370-7,380	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist, as above.
7,380-7,390	95% Quartzite, as above. 5% Phyllite/Sericite Schist, as above. Trace of Phyllite, gray; Greenschist; calcite.
7,390-7,400	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,400-7,410	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
7,410-7,420	95% Quartzite, as above. 5% Phyllite/Sericite Schist; calcite.
7,420-7,430	100% Quartzite, as above. Trace of Phyllite/Sericite Schist, as above.
7,430-7,440	100% Quartzite, as above. Trace of Phyllite/Sericite Schist, as above; calcite.
7,440-7,450	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; Greenschist.
7,450-7,460	100% Quartzite, as above; trace of bright green stain (corrosion retardant?) Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
7,460-7,470	100% Quartzite, as above.
7,470-7,480	100% Quartzite, as above. Trace of Phyllite, dark gray; calcite.
7,480-7,490	100% Quartzite, as above.

7,490-7,500	100% Quartzite, as above; trace of pyrite. Trace of Phyllite, dark gray; Phyllite/Sericite Schist; calcite.
7,500-7,510	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,510-7,520	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Greenschist; calcite.
7,520-7,530	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
7,530-7,540	100% Quartzite, as above; trace of pyrite, trace of emerald green stain (stain of $NiCl_3$?). Trace of Phyllite, dark gray; Phyllite/Sericite Schist; calcite.
7,540-7,550	100% Quartzite, as above; trace of Sericite, pyrite and bright green stain. Trace of Phyllite/Sericite Schist; dark gray, fine grained Phyllite; Marble, gray; calcite.
7,550-7,560	100% Quartzite, as above; trace of pyrite, bright green stain. Trace of Phyllite/Sericite Schist; Greenschist; calcite.
7,560-7,570	100% Quartzite, as above; trace of green stain. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
7,570-7,580	100% Quartzite, as above; with trace of green stain ($NiCl_3$?). Trace of Phyllite, dark gray; Phyllite/Sericite Schist; calcite.
7,580-7,590	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; Greenschist; calcite.
7,590-7,600	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
7,600-7,610	100% Quartzite, as above. Trace of Phyllite, gray; Phyllite/Sericite Schist; calcite.
7,610-7,620	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Greenschist; calcite.

7,620-7,630	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
7,630-7,640	100% Quartzite, as above; trace of bright green stain. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
7,640-7,650	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,650-7,660	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
7,660-7,670	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,670-7,680	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,680-7,690	100% Quartzite, as above; trace of green stain. Trace of calcite.
7,690-7,700	100% Quartzite, as above; trace of green stain. Trace of Phyllite/Sericite Schist; calcite.
7,700-7,710	100% Quartzite, as above; trace of green stain. Trace of Phyllite/Sericite Schist; calcite.
7,710-7,720	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
7.720-7,730	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
7,730-7,740	100% Quartzite, as above; trace of gray mica partings; pyrite. Trace of Phyllite/Sericite Schist, bright green stain; calcite.
7,740-7,750	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,750-7,760	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
7,760-7,770	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite; bright green stain.
7,770-7,780	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; calcite.
7,780-7,790	100% Quartzite, as above. Trace of Phyllite/Sericite Schist.

7,790-7,800	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist (as partings in quartzite).
7,800-7,810	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,810-7,820	100% Quartzite, as above. Trace of Phyllite/Sericite Schist.
7,820-7,830	100% Quartzite, as above. Trace of Phyllite/Sericite Schist.
7,830-7,840	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist.
7,840-7,850	100% Quartzite, as above. Trace of Phyllite/Sericite Schist.
7,850-7,860	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Phyllite, dark gray.
7,860-7,870	100% Quartzite, as above; trace of pyrite. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
7,870-7,880	100% Quartzite, as above; trace of green stain ($NiCl_3$?) Trace of Phyllite/Sericite Schist; calcite.
7,880-7,890	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,890-7,900	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Phyllite, dark gray; calcite.
7,900-7,910	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,910-7,920	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,920-7,930	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; Greenschist; calcite.
7,930-7,940	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.
7,940-7,950	95% Quartzite, as above. 5% Phyllite/Sericite Schist, light gray-white, as above; interlaminated with Quartzite.
7,950-7,960	100% Quartzite, as above. Trace of Phyllite/Sericite Schist; calcite.

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APPENDIX B

Baroid Mud Log, Bert Winn #1
(to be supplied by Sunedco)

Temperature, °F

50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260

Depth in feet

4,200 4,250 4,300 4,350 4,400 4,450 4,500 4,550 4,600 4,650 4,700 4,750 4,800 4,850 4,900 4,950 5,000 5,050

max. therm. (2) 3 min. on bottom

mud IN

mud OUT

Maximum reading thermometer survey 5/4
13 hrs. 5 min. after circulation
6 min. on bottom

adding water

CABLE KUSTER 1

CABLE KUSTER 2

SCHLUMBERGER RUN 1

cleaned pit

SCHLUMBERGER RUN 2

PRUETT KUSTER 1

PRUETT KUSTER 2

PRUETT KUSTER 3

max. therm. (2) 3 min. on bottom

max. therm. (2) 3 min. on bottom

losing mud over shaker adding water to mud

dumped mudpit

losing mud over shaker

max. therm (2) 3 min. on bottom

R/T at 5,013'

trip temp. 7 hrs after circulation

continuous addition of small amounts of water to mud

(1)

Temperature, °F

50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260

Depth in feet

5,050 5,100 5,150 5,200 5,250 5,300 5,350 5,400 5,450 5,500 5,550 5,600 5,650 5,700 5,750 5,800 5,850 5,900

continuous addition of water to mud

mud IN

mud OUT

trip at 5,297'

bottoms up after 5-½ hrs without circulation

lost 10 bbls 5,580'
total lost circulation 5,585'-5,710'
chloride increase in mud from 100-200 ppm to 1,200 ppm

regained circulation after setting cement plugs

adding water to replace loss over shaker

lost 15 bbls 5,897'

max. therm. 3 min. on bottom

max. therm. (2) 3 min. on bottom

max. therm. (1) 3 min. on bottom

max. therm. (2) 3 min. on bottom (after drilling out cement)

max. therm. (2) 3 min. on bottom

max. therm. (2) 3 min. on bottom

PRUETT KUSTER 3

PRUETT KUSTER 2

max. therm. (2) 3 min. on bottom incorrect ?

SCHLUMBERGER Run 2

max. therm. (2) 3 min. on bottom

SCHLUMBERGER Run 1

PRUETT KUSTER 1

CABLE KUSTER RUN 2
maximum after 20 min.
at station ΔT=1.8°F

CABLE KUSTER RUN 1
maximum after 28 min.
at station ΔT=0.6°F

(2)

Temperature, °F

50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260

Depth in feet

5,900 5,950 6,000 6,050 6,100 6,150 6,200 6,250 6,300 6,350 6,400 6,450 6,500 6,550 6,600 6,650 6,700 6,750

mud IN

mud OUT

losing 10 bbls/hr uphole? adding water trip for bit and reaming

losing 20-30 bbls/hr adding water

losing 15-20 bbls mud stopped adding water

losing 10-20 bbls mud/hr

adding water

losing 10-15 bbls mud/hr

trip for bit adding water

bottoms up temp.

losing 10-20 bbls/hr

adding water

losing 30-40 bbls/hr adding water

losing 15-20 bbls mud/hr adding water

stopped adding water

adding water

stopped adding water

adding water

max. therm. (2) 3 min. on bottom

max. therm (2) 3 min. on bottom

max. therm (2) 3 min. on bottom

SCHLUMBERGER Run 1

PRUETT KUSTER 1

SCHLUMBERGER Run 2

PRUETT KUSTER 3

max. therm 3 min. on bottom

PRUETT KUSTER 2

max. therm. 3 min. on bottom

max. therm. 3 min. on bottom

max. therm (2) 3 min. on bottom

(3)

Temperature, °F

50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260

Depth in feet

6,750 6,800 6,850 6,900 6,950 7,000 7,050 7,100 7,150 7,200 7,250 7,300 7,350 7,400 7,450 7,500 7,550 7,600

stopped adding water
adding water
losing 15-20 bbls mud/hr
water off
water on
trip for bit
changed water entry point relative to probe
mud IN
mud OUT
no water added
adding water
no water added
adding water
no water added
trip gas CO_2 = 8,000 ppm
CO_2 = 2,000 ppm
adding water
lost 80-100 bbls mud in 20 minutes
no water added
adding water
mud over shaker
probe moved
trip gas CO_2 = 6,000 ppm
no water added at time of measurement
water added continuously before and after losing 30-35 bbls/hr
no water added
adding water
stopped adding water at shaker
water added to pits
broke circulation
came out of hole to run Wireline temperature surveys
pulled out of hole
trip gas CO_2 = 4,000 ppm

max. therm. 3 min. on bottom
max. therm. 3 min. on bottom
max. therm. 3 min. on bottom
PRUETT KUSTER RUN 1
SCHLUMBERGER RUN 1
max. therm. (2)
3 min. on bottom
3 min. on bottom 45 min. after circulation
SCHLUMBERGER RUN 2
PRUETT KUSTER RUN 2
PRUETT KUSTER RUN 3
max. therm. 8 min. on bottom
15 min. 30 min. 45 min. 50 min.
start 11 hrs., 46 min. after circulation
45 min. 30 min. 15 min. start 53 min.
15 min. 30 min. 33 min.
max. therm. 3 min. on bottom
max. therm. 3 min. on bottom

(14)

Temperature, °F

50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260

Depth in feet

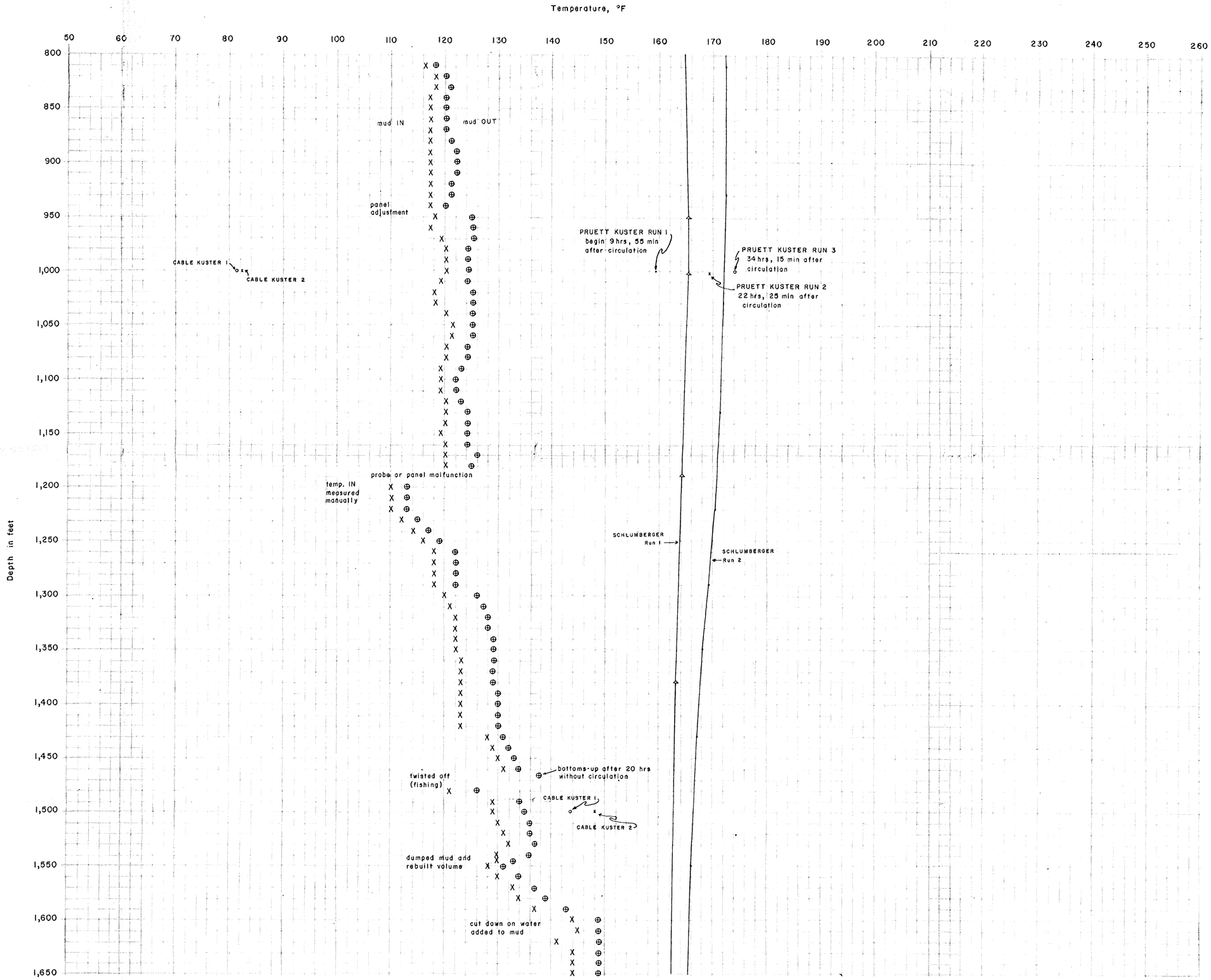
7,600
7,650
7,700
7,750
7,800
7,850
7,900
7,950
8,000

mud IN
mud OUT
adding water at flowline
adding water at shaker
water off
trip for bit adding water
decreasing mud loss
came out of hole to log 7,981' TD

max. therm. 3 min. on bottom
SCHLUMBERGER RUN 1 BOTTOM = 7,972'

max. therm. 3 min. on bottom
SCHLUMBERGER RUN 2 BOTTOM = 7,970'

(5)


Temperature, °F
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
Depth in feet
800
850
900
950
1,000
1,050
1,100
1,150
1,200
1,250
1,300
1,350
1,400
1,450
1,500
1,550
1,600
1,650
mud IN
mud OUT
panel adjustment
CABLE KUSTER 1
CABLE KUSTER 2
PRUETT KUSTER RUN 1
begin 9 hrs, 55 min
after circulation
PRUETT KUSTER RUN 3
34 hrs, 15 min after
circulation
PRUETT KUSTER RUN 2
22 hrs, 25 min after
circulation
probe or panel malfunction
temp. IN
measured
manually
SCHLUMBERGER
Run 1
SCHLUMBERGER
Run 2
twisted off
(fishing)
bottoms-up after 20 hrs
without circulation
CABLE KUSTER 1
CABLE KUSTER 2
dumped mud and
rebuilt volume
cut down on water
added to mud

Temperature, °F

50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260

Depth in feet

1,650 1,700 1,750 1,800 1,850 1,900 1,950 2,000 2,050 2,100 2,150 2,200 2,250 2,300 2,350 2,400 2,450 2,500

adding water

partial lost circulation (35 bbls mud) 1,680' pump problems

set 13-3/8" casing at 1,733'
drilling 12-1/2" hole

mud IN

mud OUT

max. therm. 3 min. on bottom

CABLE KUSTER 1

CABLE KUSTER 2

Maximum reading thermometer survey 5/4
8 hrs, 45 min. after circulation
15 min. on station

PRUETT KUSTER 1, 2, 3

SCHLUMBERGER Run 1

SCHLUMBERGER Run 2

adjust probe position

trip at 2,348'

bottoms up after 10 hours without circulation

(1)

Temperature, °F

50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260

Depth in feet

2,500 2,550 2,600 2,650 2,700 2,750 2,800 2,850 2,900 2,950 3,000 3,050 3,100 3,150 3,200 3,250 3,300 3,350

max. therm.
3 min. on bottom

mud IN

mud OUT

adjust temp. probe
previous readings may have been
low due to position of probe

max. therm.
3 min. on bottom

Maximum reading thermometer survey 5/4
10 hrs, 35 min. after circulation
13 min. on bottom

SCHLUMBERGER
Run 1

SCHLUMBERGER
Run 2

max. therm.
3 min. on bottom

CABLE KUSTER

PRUETT
KUSTER 1

PRUETT KUSTER 3

PRUETT KUSTER 2

max. therm.
3 min. on bottom

Maximum reading thermometer survey 5/4
11 hrs, 27 min. after circulation
10 min. on bottom

(8)

Temperature, °F

50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260

Depth in feet

3,350 3,400 3,450 3,500 3,550 3,600 3,650 3,700 3,750 3,800 3,850 3,900 3,950 4,000 4,050 4,100 4,150 4,200

trip at 3,387'

bottoms up 7 hrs after circulation broken

SCHLUMBERGER Run 1

SCHLUMBERGER Run 2

mud OUT

mud IN

max. therm.(1) 3 min. on bottom

adding water to mud

max. therm (2) 3 min. on bottom

Maximum reading thermometer survey 5/4
12 hrs, 20 min after circulation
6.5 min. on bottom

CABLE KUSTER 1

CABLE KUSTER 2

decreasing water addition

max. therm. (2) 3 min. on bottom

bottoms up 9 hrs. after circulation

max. therm. (2) 3 min. on bottom

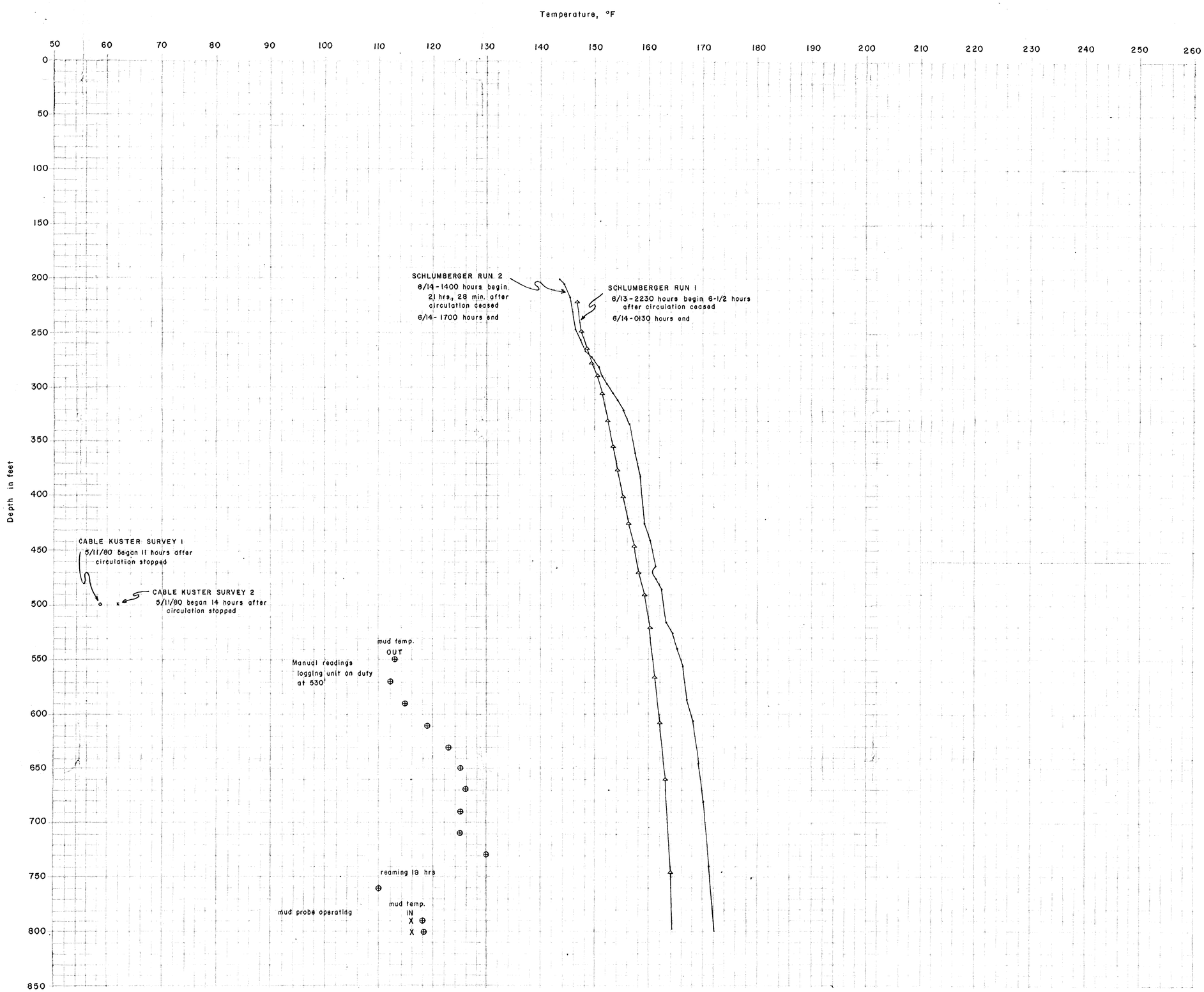
PRUETT KUSTER 1

PRUETT KUSTER 2

PRUETT KUSTER 3

(9)

PLATE 2. Bert Winn #1 summary of temperature data.



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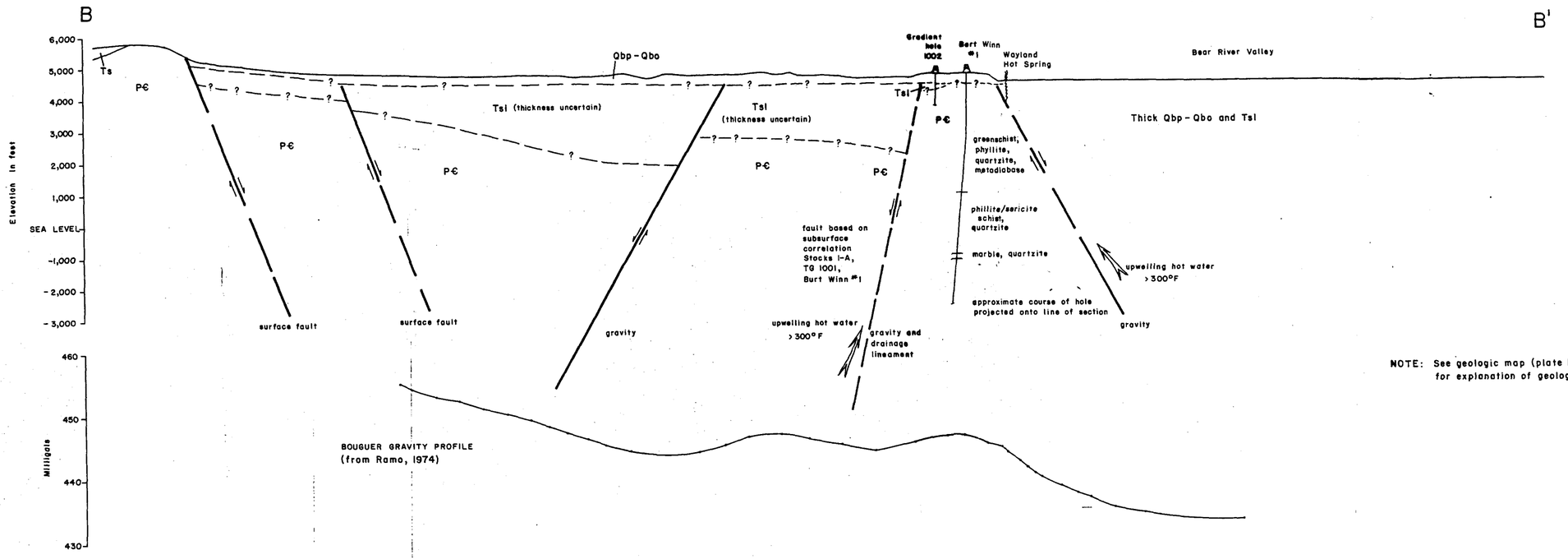
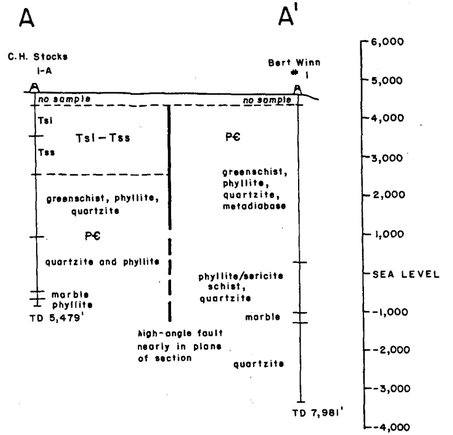
Drawn BB	Approved JRM JBK
Date 12/80	Project Sunedco





NOTE: See geologic map (plate 1 for explanation of geologic units.

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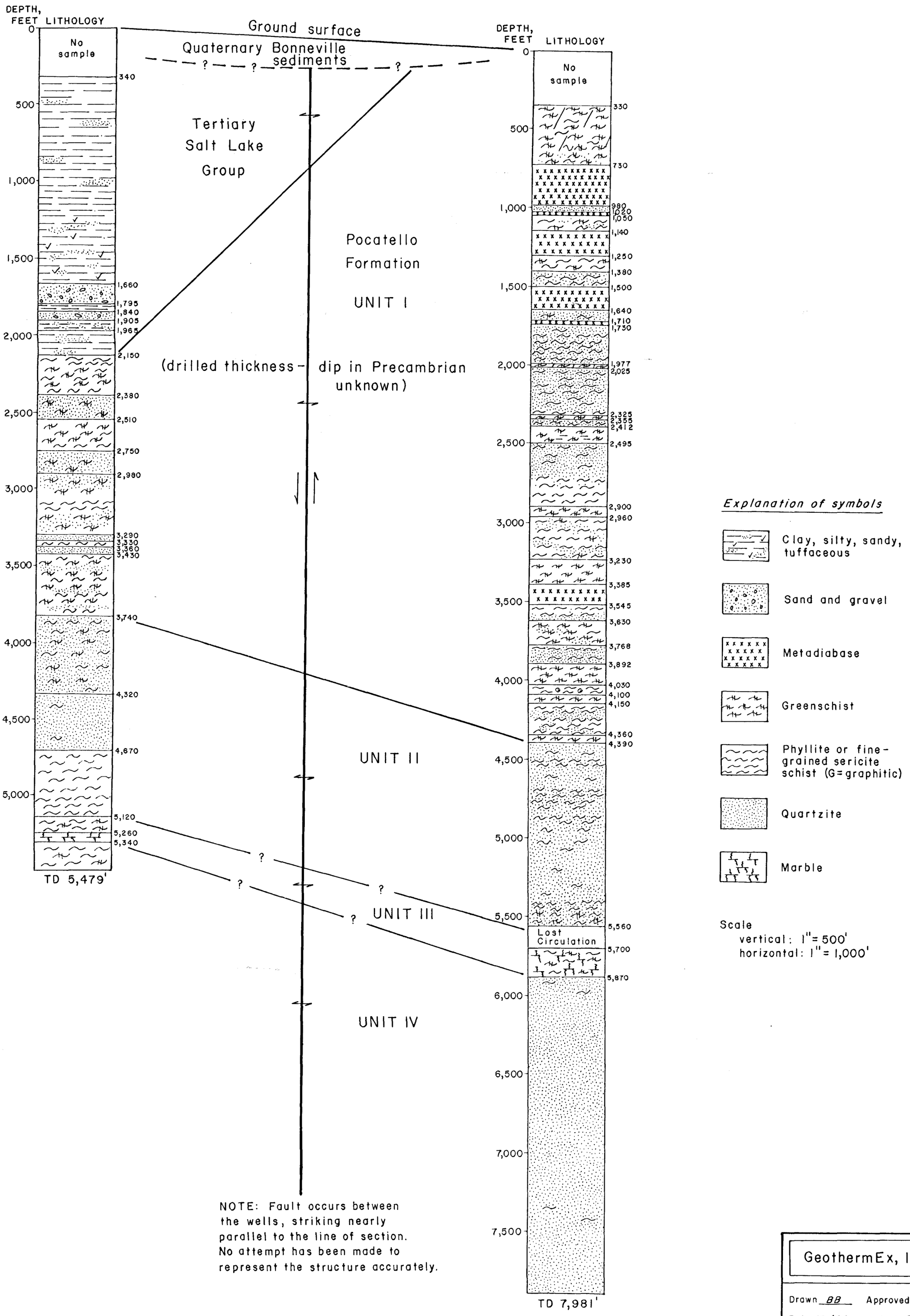
PLATE 3. Geologic cross-sections A-A' and B-B' (revised 1980).

SUNEDCO
C.H. STOCKS
I-A

SUNEDCO
BERT WINN
#1



GeothermEx, Inc.

Drawn BB Approved JRM JBK

Date 12/80 Project Sunedco

PLATE 4. Correlation diagram, Bert Winn #1 and C. H. Stocks I-A.